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Desulfurization	Leaching		07D	
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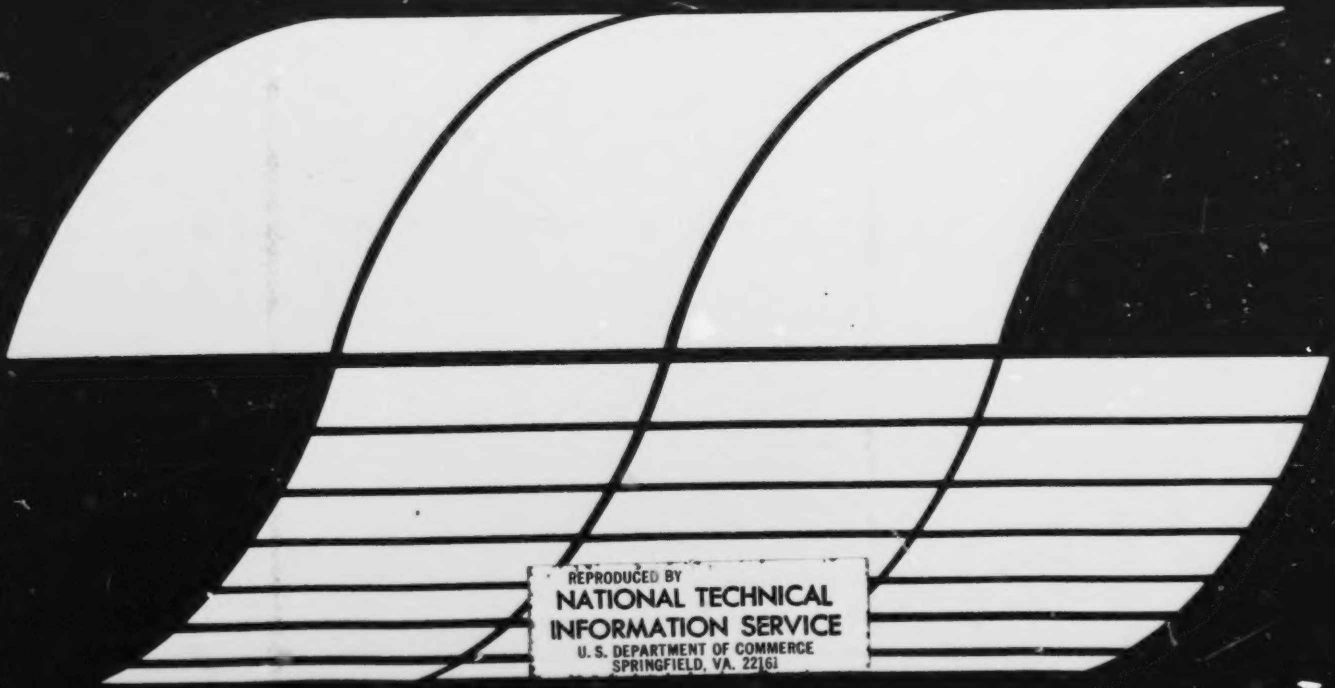

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DISPOSAL OF FLUE GAS CLEANING WASTES: EPA SHAWNEE FIELD EVALUATION - SECOND ANNUAL REPORT

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ABSTRACT

This report describes the progress made during the first two years (September 1974 through October 1976) of a field evaluation project being conducted by the U. S. Environmental Protection Agency (EPA) to assess techniques for the disposal of power plant flue gas desulfurization (FGD) sludges. The evaluation site is at the Tennessee Valley Authority Shawnee Power Station in Paducah, Kentucky. Two 10-MW prototype flue gas scrubbers, using lime and limestone, produced sludges that were placed in six test ponds. Three contain untreated sludges; each of the three remaining ponds contains sludges chemically treated by one of three commercial contractors. Test samples of treated and untreated sludges, groundwater, supernate, leachate, and soil cores are being analyzed. Results to date indicate that the maximum concentration of total dissolved solids (TDS) in the leachate of treated ponds occurred immediately after filling, or within a few months, and was approximately half that of the input liquors. Leachate from untreated ponds followed a similar pattern, except the maximum concentrations were approximately the same as the TDS of the input liquor.

After two years, TDS in the leachates of all ponds is between one-third and one-half that of the respective input liquors. Generally, the leachates from the evaluation ponds exhibit decreasing concentrations of chloride ion, and the TDS have stabilized at approximately gypsum saturation. Trace elements have exhibited little change.

Chemically treated sludges continue to exhibit good landfill strength and generally reduce the mass release of sludge constituents to the subsoil by at least two orders of magnitude.

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CONVERSION TABLE

British	Metric
1 acre	4047 square meters
1 British thermal unit per pound	2.235 Joules per gram
1 foot	0.3048 meter
1 cubic foot	28.316 liters
1 inch	2.54 centimeters
1 gallon (U.S.)	3.785 liters
1 pound	0.454 kilogram
1 mile	1.609 kilometers
1 ton (short)	0.9072 metric ton
1 ton per square foot	9765 kilograms per square meter
1 part per million	1 milligram per liter (equivalent)
1 pound per square inch	0.0703 kilogram per square centimeter
1 cubic yard	0.7641 cubic meter

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SECTION I

INTRODUCTION

In September 1974, the U. S. Environmental Protection Agency (EPA) initiated a program for the field evaluation of the disposal of wastes from power plant flue gas desulfurization (FGD) systems. The purpose of this program was to evaluate the effects of various disposal techniques, scrubbing operations, soil interactions, and field operations procedures on the environmental quality of the disposal site.

The site chosen for the evaluation was the Tennessee Valley Authority (TVA) Shawnee Power Station at Paducah, Kentucky. Two different scrubber systems functioning in parallel are being operated at this station as an EPA/TVA test facility, with the Bechtel Corporation as the scrubber test director. Each of the scrubbers, i. e., a Universal Oil Products (UOP) turbulent contact absorber (TCA) and a Chemico venturi followed by a spray tower, is capable of treating up to 10 MW (equivalent) of flue gas. Sludges from these scrubbers, using lime and limestone as the SO_2 absorbent, are being used in the disposal evaluation program. This program provides a broader data base for the evaluation of flue gas SO_2 control by combining evaluations of scrubber performance and sludge disposal at the same site; laboratory analyses are being conducted concurrently.

Initially, the disposal program involved five impoundments (ponds), each occupying approximately 0.1 acre. Two of these ponds contained untreated sludge, and three contained sludge that had been chemically treated. During 1976, the program was expanded to provide for three additional ponds to be filled with ash-free lime sludge, ash-free limestone sludge, and oxidized sulfate (gypsum) sludge. All three sites were constructed, and the pond designated for ash-free lime sludge was filled in October 1976. The remaining two sites were scheduled to be filled early in 1977.

The objectives of the disposal evaluation program are as follows:

a. Evaluate current disposal techniques under critical field operating conditions.

b. Evaluate the environmental acceptability of current disposal technology through periodic sampling, analysis, and assessment of water, soil, and sludge cores.

c. Develop engineering cost estimates for alternative disposal methods on an operational basis.

This is the second report to be issued on this project. The first report (Ref. 1) discussed the results obtained on the program from September 1974 through July 1975. This report contains the data and results of analyses generated from September 1974 through October 1976. Some updates have been made for clarity during the publication period. The engineering cost estimates for various chemical treatment disposal methods were discussed in detail in the initial report (Ref. 1) and are not discussed in detail here since the costs have not changed significantly in the interim. A brief review of the current disposal cost estimates including ponding of untreated sludge is presented in the Summary section of this report.

The effort being reported on in this document is part of a broad range of FGD waste disposal study activities, the results of which have been described in other reports. The most recent report (Ref. 2) provides the results of the chemical characterization and physical properties analyses for untreated and treated wastes from seven different scrubbers at eastern and western plants using lime, limestone, or double-alkali absorbents. It also provides cost estimates for the disposal of untreated waste in lined or unlined ponds and for the disposal of chemically treated waste. Therefore, the results described in this document are oriented toward the specific activities at the TVA Shawnee station, and, where appropriate, references have been made to relate this work to the general field of FGD waste disposal.

SECTION II

CONCLUSIONS

This field evaluation project has not been completed, and therefore final conclusions are not given; however, the following interim findings are significant:

a. The maximum concentration of total dissolved solids (TDS) in the leachate of ponds containing treated sludge occurred immediately after filling, or within a few months, and was approximately half that of the input liquors. Leachate of ponds containing untreated sludge followed a similar pattern, except the maximum concentration levels were approximately the same as the TDS of the input liquor.

b. After approximately two years, the concentration of TDS in the leachates of all ponds are between one-third and one-half the TDS concentrations of their respective input liquors. If these trends continue, all ponds will reach gypsum saturation concentrations approximately four to five years after initial disposal.

c. The groundwaters being monitored for all ponds show no effects attributable to either treated or untreated sludge disposal.

d. Chemical treatments evaluated in this project do not tend to reduce concentrations of trace elements in the sludge leachate; however, chemical treatment has been shown to minimize the release of leached sludge constituents to the subsoil through decreased permeability of the treated material and the elimination of standing water due to the amenability of the material to compaction and contouring during placement. Thus, at least a two order of magnitude reduction of mass release to the subsoil can be gained with chemically treated sludge as compared to untreated sludge. Laboratory results for unconfined compressive strengths of chemically treated sludges from this project have ranged from 10 to 50 psi. Load-bearing strengths determined in the field are in excess of 60 psi.

e. The results of laboratory and field tests show that the load-bearing strength of untreated sludge can be significantly increased to greater than 35 psi if an underdrain system is used. After rewetting by rainfall, underdrained sludge regains its strength within one day. However, even at these increased strengths, the material still exhibits thixotropic characteristics while sustaining loads. Further study is needed to define its value as a landfill material.

SECTION III

RECOMMENDATIONS

This field evaluation project continues to provide data which are extremely valuable in verifying analytical and laboratory prediction techniques, thereby making those techniques of greater value to industry. Of equal importance, data are being obtained which are available solely from a field site, e.g., weather effects, soil variations and characteristics, human factors, and operational considerations. It is therefore recommended that the project be continued and that the following specific disposal conditions be evaluated:

a. Pond retirement, in which ponds containing treated and untreated sludges are covered with earth, contoured, and landscaped. Leachate collection and analysis would be continued after the ponds have been retired, and any changes in leachate quality would be evaluated as well as structural qualities and capability to support the growth of plants and trees.

b. Runoff evaluation in which a pond containing treated sludge would be sloped, simulating a possible landfill condition. The runoff would be collected and analyzed.

c. Evaluation of the disposal of oxidized sulfite sludge in terms of environmental acceptability, physical characterization, and cost.

d. Extended effects of weathering and time on the chemistry and strength of the disposed materials.

e. Extended effects of weathering and time on the operability of underdrain systems.

f. Disposal of sludge from any new scrubber installations at the TVA Shawnee test site.

SECTION IV

SUMMARY

The flue gas desulfurization (FGD) disposal field evaluation program at the Tennessee Valley Authority (TVA) Shawnee Steam Plant has been under way since September 1974. The program is being conducted to assess various disposal techniques and field operating procedures involving FGD sludge on the environmental quality of the disposal site. Currently, six disposal ponds are under evaluation, and construction has been completed for two additional ponds (which were filled early in 1977). A summary of the sludge types being used and data on the respective ponds is shown in Table 1. Three ponds contain untreated sludge, and the remaining ponds contain sludges treated by three different chemical processes. A description of the treatment processes and estimates of their respective costs are contained in Reference 1. All ponded sludges contain approximately 40 percent fly ash on a dry weight basis, the fly ash either being present during scrubbing or added during disposal.

Six disposal ponds were filled between 7 October 1974 and 5 October 1976; data taken through 31 October 1976 are discussed in this document. Evaluation of the ponds is continuing, and more recent data will be published in the next annual report. All ponds are monitored for leachate, supernate, and groundwater quality and for the characteristics of the soil on the pond bottom. Sludge cores are also evaluated on those ponds containing chemically treated material. The significant results and trends observed to date are summarized in the following paragraphs.

4.1 UNTREATED SLUDGE

4.1.1 Leachate

Since Pond G was filled just prior to the preparation date of this report, i.e., October 1976, no data for this pond are presented here. However, analyses of leachate from ponds A/A1 and D are shown in Figures 1 and 2; these figures show that the concentrations of total dissolved solids (TDS) increased steadily after filling and after a period of approximately 40 weeks (during which the leachate was diluted with rainwater initially in the well and well area) reached peak levels close to those measured in the input liquor. Thereafter, the TDS and chloride levels

TABLE 1. SHAWNEE POND FILL DATA

Pond	Fill Date	Scrubber Type	Sludge		Solids Content, wt%	Treatment Contractor
			Source	Absorbent		
A	10/8/74	Venturi and spray tower	Lime	Filter	46	Untreated
A1[a]	5/10/76	Venturi and spray tower	Lime	Filter	46	Untreated
B	4/15/75	Turbulent contact absorber	Limestone	Clarifier underflow	38[b]	Dravo
C	4/23/75	Venturi and spray tower	Lime	Centrifuge	55[b]	IU Conversion Systems
D	2/5/75	Turbulent contact absorber	Limestone	Clarifier underflow	38	Untreated
E	12/7/74	Turbulent contact absorber	Limestone	Clarifier underflow	38[b]	Chemfix
G	10/5/76	Venturi and spray tower	Lime	Centrifuge	42	Untreated

[a] Transferred from Pond A.

[b] Prior to chemical treatment.

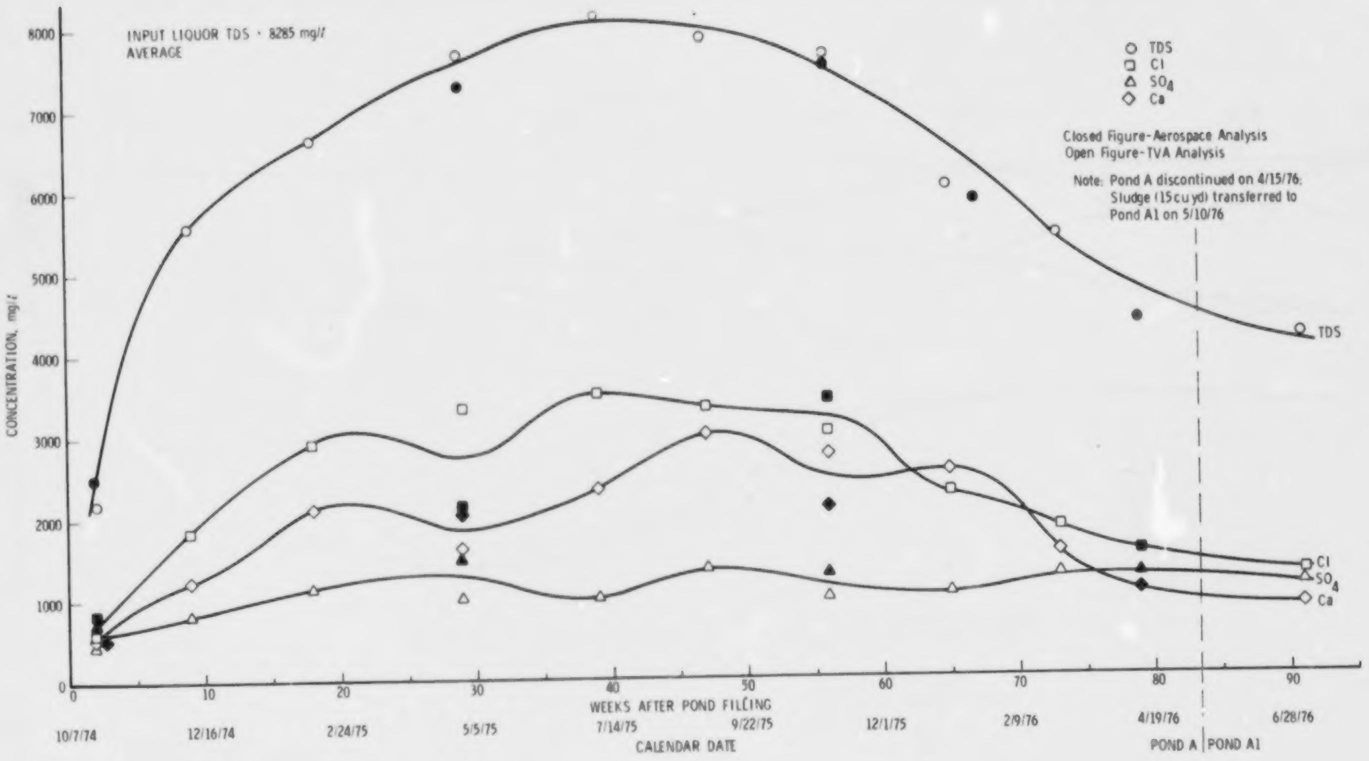

Figure 1. Concentrations of TDS and major species in Pond A/A1 leachate

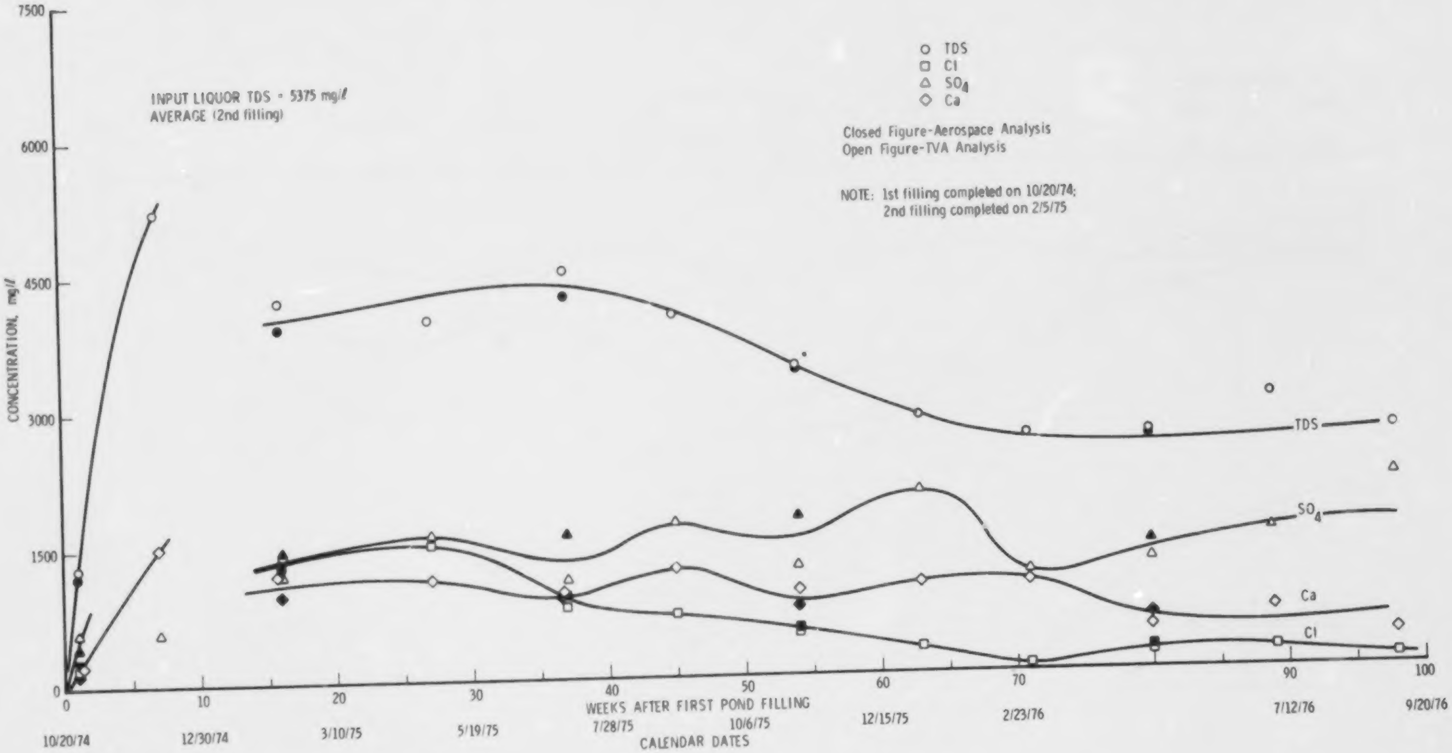

Figure 2. Concentrations of TDS and major species in Pond D leachate

dropped steadily in both ponds. The concentrations of the significant minor constituents, which span a range of six orders of magnitude, were relatively constant over most of the period monitored and show no discernible trends related to chemical treatment or absorbent (Section 4. 5. 3).

4. 1. 2 Supernate

The concentrations of TDS (and the major constituents which comprise TDS) in the supernates of these ponds decreased with time from initial values corresponding to the values measured in the input liquor. After the initial decrease, fluctuations were observed in which concentrations increased during hot, dry weather as a result of net water loss by evaporations and decreased again when cooler weather and increased rainfall caused additional dilution. Mass balance calculations will be conducted during the coming year to assess the effects of solubility, diffusion, and weather as related to supernate TDS concentrations.

4. 1. 3 Groundwater

The analysis of groundwater shows no indication of increases in concentration levels attributable to the ponds. For Pond A, there is a discernible trend showing a decrease in the TDS level toward the end of the monitoring period. In Pond D, the concentrations of calcium and sulfate remained relatively constant during the monitoring period, whereas the concentration of chloride and TDS increased. During this period, the fact that, in the leachate, calcium and sulfate concentrations were low and constant, and the chloride concentration decreased, indicates that the increase of chloride and TDS concentration levels in the groundwater was not a consequence of the pond.

4. 1. 4 Physical Characteristics

The compressive strengths of untreated sludges placed in undrained ponds, such as A and D, have been too low to permit walking on their surfaces. In preparation for the filling of Pond G, laboratory tests were conducted on ash-free lime sludge filter cake (obtained from the Chemico venturi/srpay tower) remixed with fly ash in a quantity representing 40 weight percent of total solids. The samples were allowed to settle or drain to obtain bearing strength measurements as a function of settling or draining time. The test results showed that undrained settling alone would not produce bearing strengths above 40 psi (in a modified California Bearing Ratio Test) after a settling time of 13 days. Samples which were allowed to drain, however, showed significant increases in bearing strength in a relatively short time. Samples in which half the fly ash was remixed in the sludge and the other half placed in layers showed bearing strengths of greater than 20 psi in 12 hours and greater than 50 psi in 24 hours. This layered structure was selected for the filling of Pond G, and it was demonstrated during filling (between 2 and 10 hours after placing the sludge and fly ash in the pond) that the material supported site personnel. Subsequent tests with wheeled vehicles demonstrated that although the material still exhibited thixotropic properties, it had a bearing strength of at least 35 psi. Future evaluations will determine the ability of this material to support wheeled vehicles as a function of time and weather.

4.2 TREATED SLUDGE

4.2.1 Leachate

The analyses of leachate from the ponds containing treated sludge show data trends similar to the untreated ponds; however, the concentrations of TDS consistently remain at a level approximately one-half or less of those found in the input liquor. The results of leachate analyses are presented in Figures 3 through 5 for Ponds B, C, and E, respectively. The six minor constituents analyzed remained at relatively constant levels (Section 8) at about the level of concentrations in untreated input liquor (or greater) throughout the monitoring period, with the exception of the boron concentration in Pond C, which showed an initial reduction compared to input liquor and then increased steadily to a level approaching that of the input liquor.

Pond B simulates storage and stabilization of sludge behind a dam, and Ponds C and E simulate conditions representing a low spot in a landfill in which rainwater is allowed to collect.

4.2.2 Supernate

The concentrations of major constituents and TDS in the supernate of the treated sludge ponds varied as a function of dry and wet weather during the monitoring period and reached peaks at values between one-half to two-thirds of corresponding constituents in the input liquor.

4.2.3 Groundwater

The groundwater analysis results show that the major constituents and TDS remain essentially constant over a monitoring period starting as early as 22 weeks prior to filling, and no trends attributable to the ponds have been observed.

4.2.4 Physical Characteristics

Laboratory tests were performed on core samples removed from ponds containing treated sludge to determine the physical and chemical characteristics of these materials. The results show that there were no time-dependent trends in the permeability of these sludges and the average permeability coefficients were 7×10^{-5} cm/sec for Pond B, 2×10^{-5} cm/sec for Pond E, and 5×10^{-5} cm/sec for Pond C, with selected crack-free samples exhibiting coefficients of 3×10^{-7} cm/sec. The compressive strengths of free-standing samples of these same materials did not appear dependent on moisture content and ranged from 426 psi for Pond C to 56 psi and 114 psi for Ponds B and E, respectively. Details on the testing, analysis, and environmental benefits of chemically treated sludges are discussed in Sections 4.5.1, 7.3, 8.2, 8.3, and Appendix C.

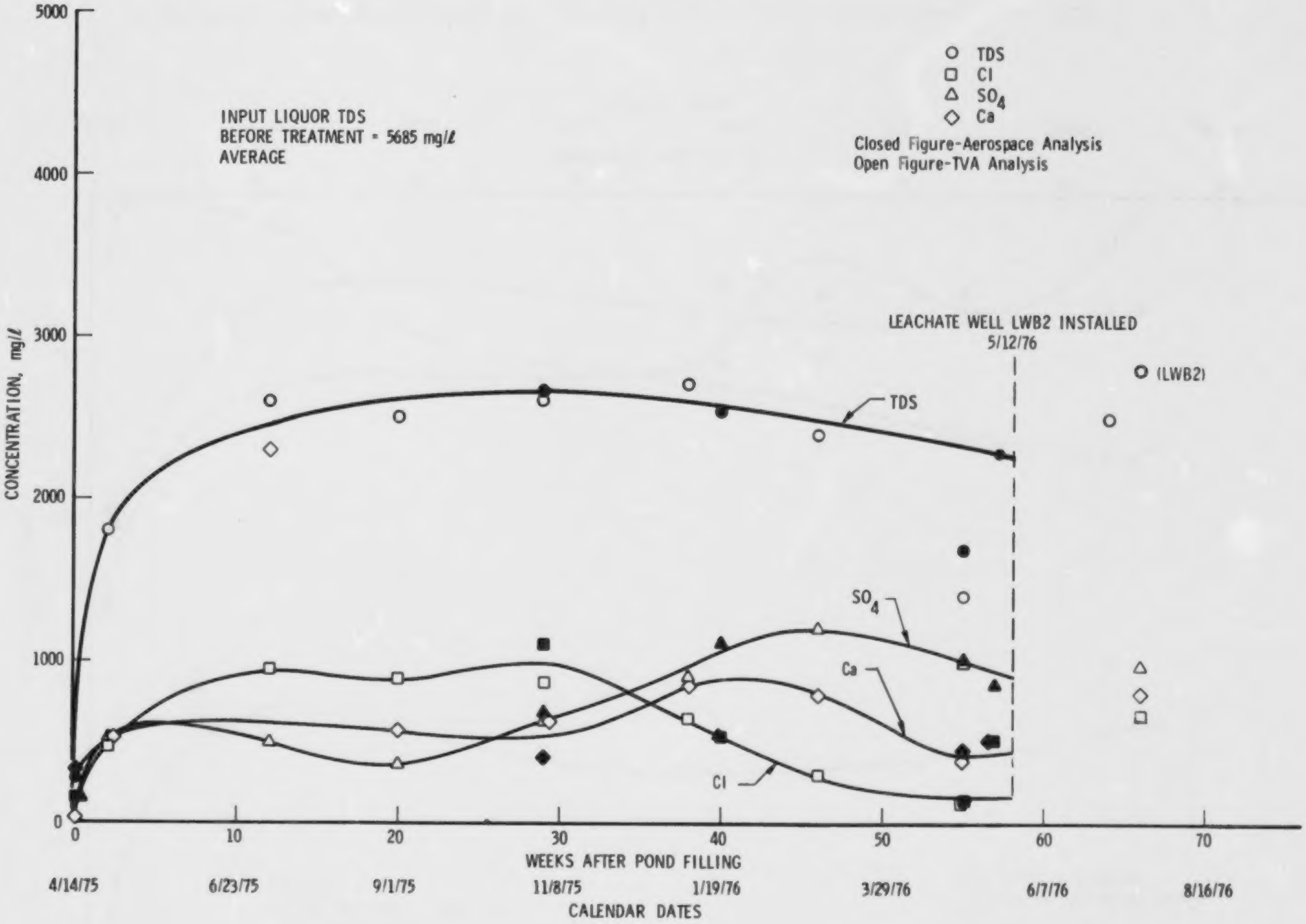

Figure 3. Concentrations of TDS and major species in Pond B leachate

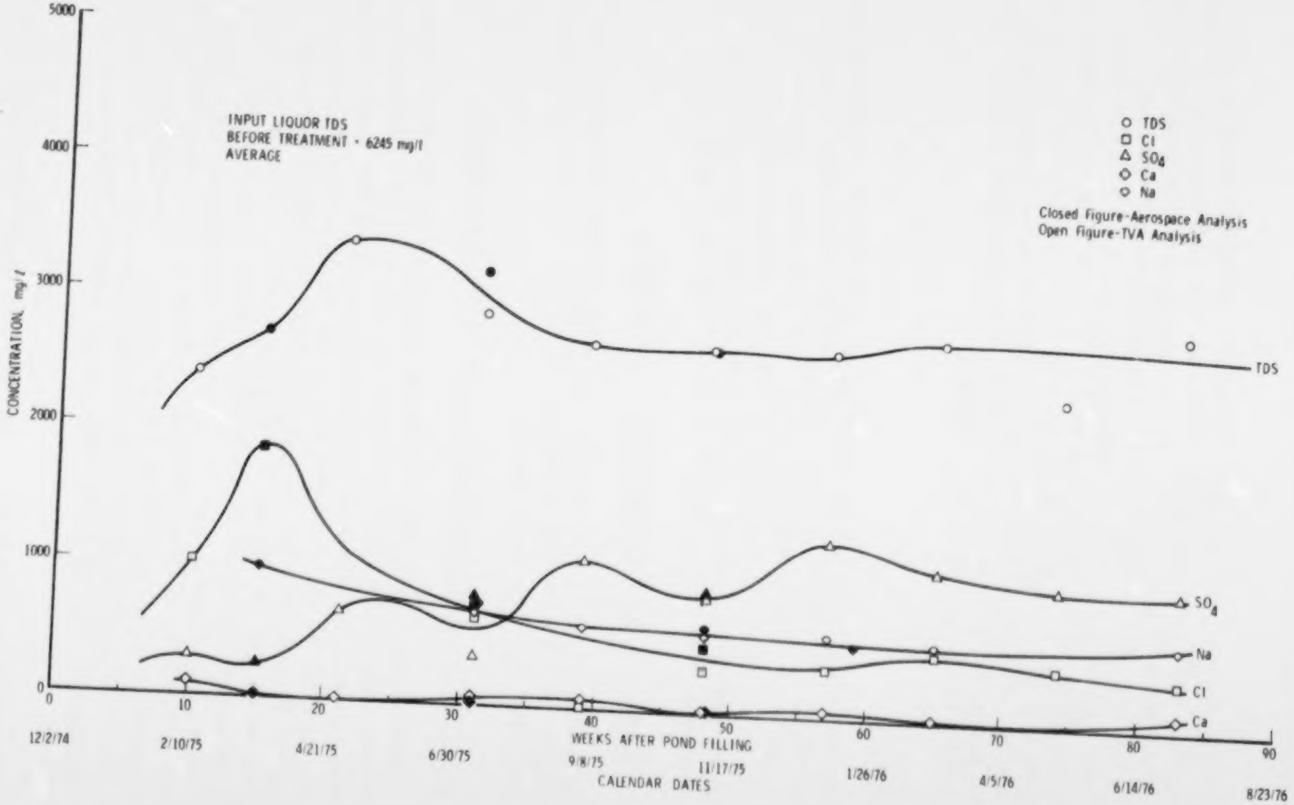

Figure 5. Concentrations of TDS and major species in Pond E leachate

4.3 SOIL

Undisturbed soil core samples were removed and tested by TVA during the construction of groundwater wells for several new ponds in May 1976. The results show that the clay soil has a dry density of 1.6 to 1.8 gm/cm^3 and a permeability coefficient of approximately 2 to 6×10^{-7} cm/sec.

For all ponds, the rate of leachate penetration into the subsoil is controlled by the soil permeability because the permeability of the soil is equal to or less than that of either of the sludges. Permeability coefficients for the chemically treated sludges are typically 5×10^{-5} cm/sec. The untreated materials have coefficients approximately 2×10^{-4} cm/sec. Based on a soil permeability coefficient of 2 to 6×10^{-7} cm/sec, the rate the leachate is expected to travel is about 0.5 to 1.5 cm (0.2 to 0.6 in.) per month. Therefore, during the two-year period that the ponds have been in operation, the leachate is estimated to have traveled approximately 12.4 to 37.2 cm (5.0 to 15.0 in.) into the subsoil.

4.4 COSTS

Engineering cost estimates were presented, in the initial report on this project (Ref. 1), for the total costs associated with disposal of treated Shawnee-type sludge. Since that time as part of a separate study, additional engineering cost estimates have been prepared that include disposal of untreated sludge in ponds containing both natural clay and synthetic liners (Ref. 2). A summary of these costs is presented in Table 2.

4.5 SUMMARY OF SIGNIFICANT RESULTS

In addition to the specific data discussed above for the various project elements, the following results, at an overall project level, have been obtained which appear significant.

4.5.1 Environmental Benefits of Chemical Treatment

Chemical treatment has been found to have major benefits which effectively minimize (and possibly in some cases eliminate) the release of leached sludge constituents to the subsoil through (1) the decreased permeability of the treated material and (2) the amenability of the treated material to compaction and contouring during placement so that standing water does not occur at the disposal site. The prevention of standing water eliminates the need for a hydraulic head on the site; thus, seepage through the pores does not occur as a result of hydraulic pressure. Therefore, the major portion of the rainfall on such a site runs off; this is managed by means of collection of runoff in a peripheral ditch which directs the water to a settling pond from which decanted liquor is disposed of in an adjacent stream or river (see Reference 2 for a discussion of site management).

Under worst-case conditions, the formation of cracks in the

TABLE 2. DISPOSAL COST RANGES (UNTREATED AND TREATED SLUDGE 1000-MW STATION, 50 PERCENT LOAD FACTOR 30-YEAR AVERAGE, JANUARY 1976 DOLLARS)

Disposal Method	Base Material	\$/Ton Sludge[a, b] (Dry)	\$/Ton Coal[b]	Mills/ kWh[b, c, d]
Untreated Pond	Natural clay[e]	3.50	1.00	0.43
Pond	Liner[f]	5.70 to 7.80	1.60 to 2.20	0.7 to 1.0
Treated[g]	Indigenous soil	7.30 to 11.40	2.10 to 3.20	0.9 to 1.4

[a] 510,000 short ton/yr average (dry basis), including fly ash.

[b] Coal burned at rate of 0.88 lb/kWh, 3% sulfur, 12% ash, 85% SO_2 removal, 1.2 $CaCO_3/SO_2$ mole ratio.

[c] Land costs at \$1000/acre are included (equivalent to \$0.25/ton sludge, dry).

[d] Disposal within 5 miles of power plant.

[e] Assumes coefficient of permeability of clay is 1×10^{-6} cm/sec or lower.

[f] Ponding costs cover range based on low-to-high material costs, i.e., PVS-20 mil thickness (low) to Hypalon-30 mil thickness (high).

[g] Treatment costs vary, depending on characteristics of the waste and the disposal process chosen.

treated material could allow some seepage if a portion of the site is continuously exposed to collected rainfall. To account for this, tests to determine permeability of chemically treated sludges were performed on cores extracted from the Shawnee field evaluation site. Constant-head permeability tests were run on (1) pulverized samples, and (2) samples with and without visible cracks. The uncracked samples had coefficients of permeability of about 10^{-7} cm/sec; the pulverized and the cracked samples had coefficients of approximately 10^{-5} cm/sec. Therefore, the effective coefficient could be between 10^{-5} and 10^{-7}. Assuming a worst case (using a coefficient of permeability of 10^{-5} cm/sec), an order of magnitude improvement in impermeability is realized compared to untreated sludges which typically have a coefficient of about 10^{-4} cm/sec. Further, the elimination of standing water via runoff reduces the recharge of water to the site. If it is assumed that 10 percent of the net rainfall is recharged, then a two-order of magnitude improvement is gained when comparing the mass seepage from a chemically treated site to that of a ponded untreated site. This approach was taken in the determination of comparative mass releases of sludge to subsoil from different types of disposal sites shown in the example cases given in Appendix C; these data are repeated from a companion report (Ref. 2), which correlates the results of the Shawnee evaluation with laboratory data. The significance of eliminating standing water and improving impermeability are discussed in that study. Furthermore, the management of a chemically treated disposal site by compaction during its development should appreciably reduce the quantity of cracks and eliminate the continuity of cracks that may appear, so that an effective coefficient of permeability, better than 10^{-5} cm/sec, should be realized, as well as a rainfall recharge of less than 10 percent. Therefore, the net effect may well be an improvement far in excess of two orders of magnitude.

Some chemically treated sludges are disposed of in a lake which maintains a hydraulic head on the site at all times (see Case No. 2 in Appendix C). The mass release for such a case is approximately one-fourth that from an untreated pond. Sites of this type may seep to adjacent streams, which can reduce the concentration of constituents by mixing. Historical data regarding stream characteristics and quality which can provide adequate mixing and the monitoring of streams are necessary to qualify sites of this type for environmental acceptability.

4.5.2 Control of Leachate from Untreated Waste

The data obtained to date on the concentration of dissolved solids in the leachates of untreated sludge show that peak levels are reached which are virtually the same as those of the input sludge liquor. These concentration levels have been found, in other Aerospace studies (Ref. 2), to exceed drinking water criteria; therefore, some form of control is needed. In addition to the use of impermeable liners or soils, one method being investigated as part of this project is the use of an underdrain system whereby the underdrained water is returned to the scrubber loop for reuse. An underdrain vented to the atmosphere minimizes seepage by eliminating the hydraulic head of the leachate. The gravity head of any accumulated surface water is adequate to provide for rapid removal of rainfall recharge.

This technique has the potential for increasing the bearing strength of the sludge to levels useful in a landfill. This disposal operation has been investigated in laboratory tests and will be evaluated in the field for several sludge types (Section 6.2.2). A water balance analysis has shown that this mode of closed loop operation (with underdrainage return) can be achieved, including the maintenance of tolerable chloride ion levels (Ref. 3).

4.5.3 Concentration of Minor Constituents

The concentrations of minor constituents in the leachates of the FGD sludges at Shawnee have shown no discernible trends related to chemical treatment or absorbent. A comparison of typical trace element concentrations with those of the input liquors for the respective ponds is shown in Table 3.

TABLE 3. TYPICAL LEACHATE CONCENTRATION OF MINOR CONSTITUENTS VERSUS INPUT LIQUOR

Element	Concentration, mg/ℓ									
	Untreated Ponds				Chemically Treated Ponds					
	Ponds A and A1		Pond D		Pond B		Pond C		Pond E	
	Input Liquor	Leachate	Input Liquor	Leachate	Input Liquor	Leachate	Input Liquor	Leachate	Input Liquor	Leachate
Arsenic	0.024	0.008	0.004	0.3	0.004	0.03	0.002	0.02	0.003	0.005
Boron	44	30	93	20	97	1.5	34	2	80	0.5
Lead	0.49	0.05	<0.02	0.04	<0.02	0.04	<0.01	0.02	<0.01	0.04
Magnesium	290	60	50	50	2.5	30	33	10	12	2
Mercury	<0.0001	0.001	0.00033	0.0007	0.00024	0.0006	<0.00008	0.0005	0.00033	0.001
Selenium	0.005	0.005	0.014	0.01	0.02	0.015	0.018	0.015	0.014	0.01

SECTION V

ORGANIZATION AND MANAGEMENT

This program is managed by the EPA Industrial Environmental Research Laboratory, Research Triangle Park, North Carolina. The functional relationships of the other organizations participating in the program are shown in Figure 6.

The Aerospace Corporation is responsible for program coordination, writing and maintaining the program plans, selected analyses, evaluation and assessment of all analytical results including costing, and reporting of program activities and analyses.

The Tennessee Valley Authority (TVA) is responsible for all construction, filling of untreated ponds, supplying sludges to treatment processors at the site, site maintenance, sampling and analyses, sample distribution, climatological and hydraulic data collection, photographic documentation (still and motion picture), and contracting with sludge treatment processors. TVA also provides analytical data, climatological and hydraulic data, and photographic documentation to The Aerospace Corporation for assessment and inclusion in formal reporting to EPA.

The sludge treatment processors are Chemfix, Inc., Pittsburgh, Pennsylvania; Dravo Corporation, Pittsburgh, Pennsylvania; and IU Conversion Systems, Inc., Philadelphia, Pennsylvania.

The Bechtel Corporation provides the technical interface relating the scrubber test facility to the disposal demonstration.

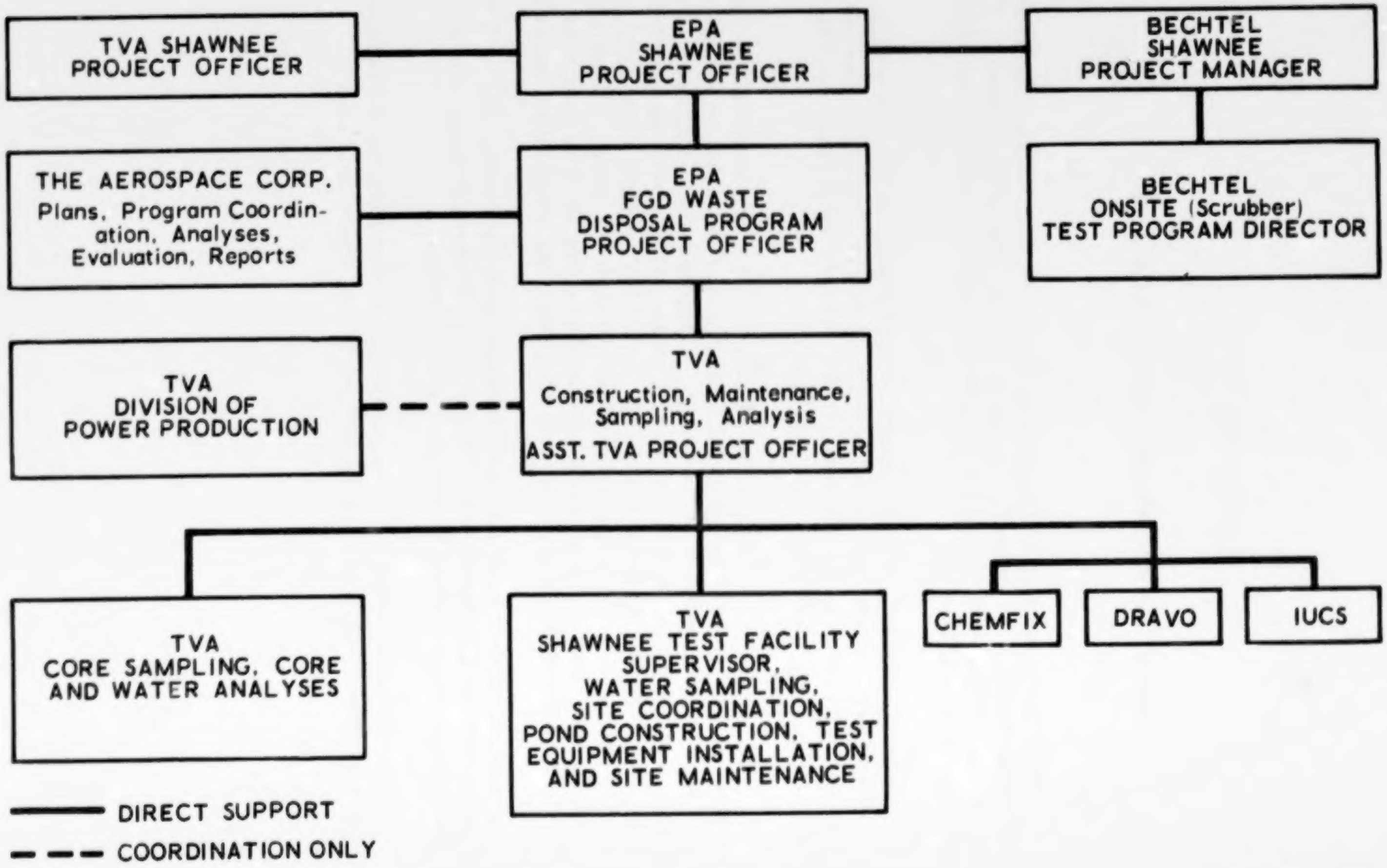
TVA SHAWNEE PROJECT OFFICER
EPA SHAWNEE PROJECT OFFICER
BECHTEL SHAWNEE PROJECT MANAGER
THE AEROSPACE CORP. Plans, Program Coordination, Analyses, Evaluation, Reports
EPA FGD WASTE DISPOSAL PROGRAM PROJECT OFFICER
BECHTEL ONSITE (Scrubber) TEST PROGRAM DIRECTOR
TVA DIVISION OF POWER PRODUCTION
TVA Construction, Maintenance, Sampling, Analysis ASST. TVA PROJECT OFFICER
TVA CORE SAMPLING, CORE AND WATER ANALYSES
TVA SHAWNEE TEST FACILITY SUPERVISOR, WATER SAMPLING, SITE COORDINATION, POND CONSTRUCTION, TEST EQUIPMENT INSTALLATION, AND SITE MAINTENANCE
CHEMFIX
DRAVO
IUCS
DIRECT SUPPORT
COORDINATION ONLY

Figure 6. EPA Shawnee disposal field demonstration functional organization

SECTION VI

SITE AND FACILITY DESCRIPTION

The site on which the disposal evaluation is being conducted is located on Tennessee Valley Authority (TVA) property, approximately 0.5 miles from the TVA Shawnee Steam Plant near Paducah, Kentucky. The Shawnee plant has 10 generating units capable of producing a total of 1,750,000 kW of electric power. At its typical level of operation, Shawnee consumes 4,500,000 ton/yr of bituminous coal from western Kentucky and Illinois (Ref. 4). This coal has an average sulfur content of approximately 3.5 percent.

6.1 TEST FACILITIES

Two prototype wet lime and limestone scrubbers, each capable of treating approximately 30,000 cu ft/min (at 300° F) of flue gas, are currently operating in parallel on Shawnee boiler No. 10 (Ref. 5). Gas that is ash-free, or containing ash, may be fed to either scrubber. The two scrubbers, each of which treats an equivalent of 10 MW of boiler capacity, produce an effluent slurry containing sulfite, sulfate, chloride, calcium and trace elements. The effluent is pumped to a thickener area from which sludge can be removed from a clarifier, centrifuge, or filter for placement in one of six disposal areas. Both treated and untreated sludges are being analyzed in the evaluation program.

6.2 PONDS

The disposal areas are identified as Ponds A1, B, C, D, E, F, G, and H and are shown in relation to the power plant in Figure 7. Ponds F and H were not filled as of October 1976* and thus are not included in the six ponds evaluated in this report. Pond A1 was constructed in May 1976 to accommodate sludge originally placed in Pond A. The Pond A site was abandoned in April 1976 to make room for the expansion of the power plant coal storage facilities, and approximately 1100 cu ft of sludge was removed from Pond A, stored, and then transferred to Pond A1.

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* Pond F was subsequently filled in February 1977 and Pond H in September 1977. These ponds are being evaluated, and the results will be available in a later publication.

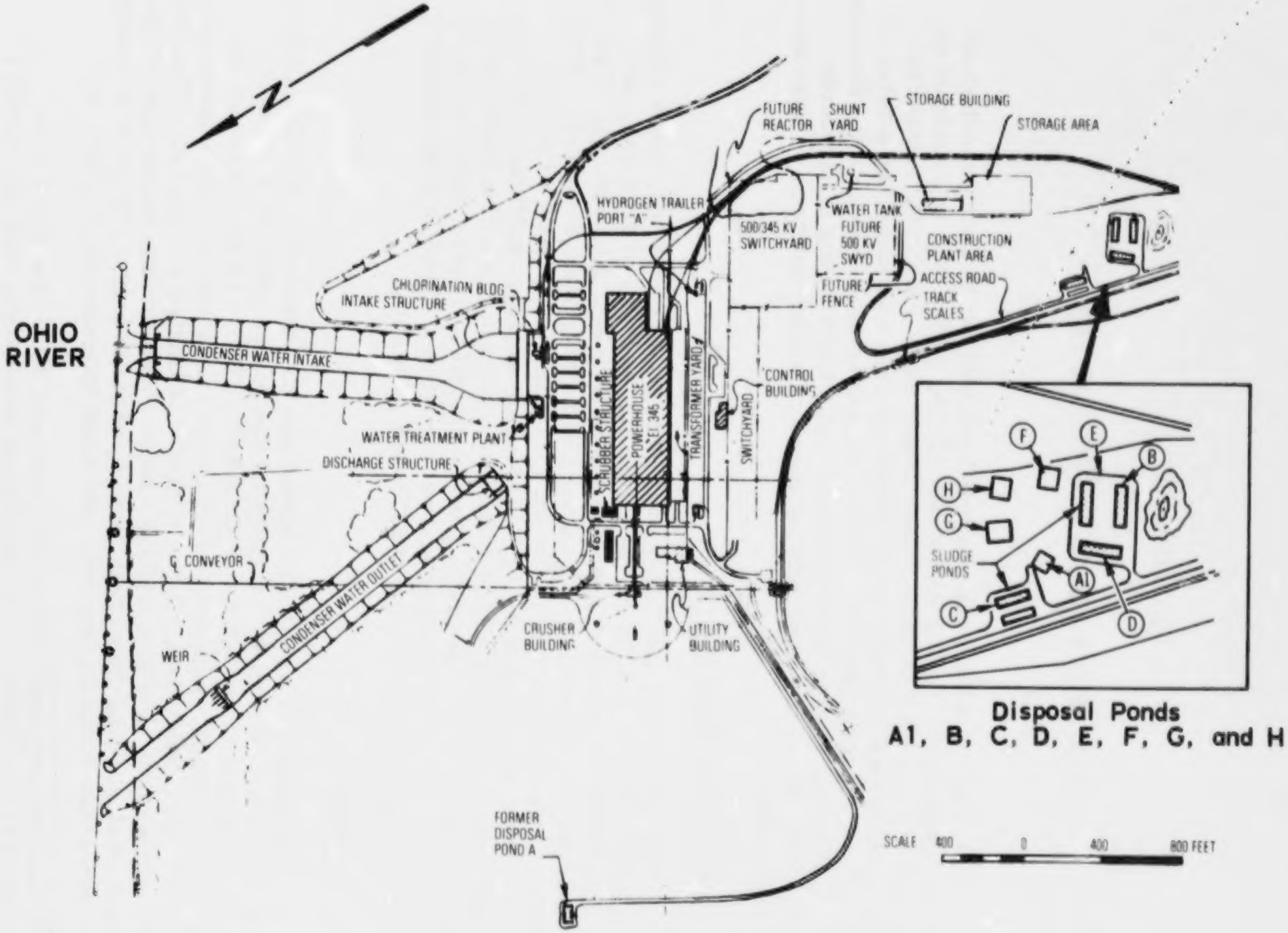

N
FUTURE REACTOR
SHUNT YARD
STORAGE BUILDING
STORAGE AREA
HYDROGEN TRAILER PORT "A"
500/345 KV SWITCHYARD
WATER TANK
FUTURE 500 KV SWYD
CONSTRUCTION PLANT AREA
ACCESS ROAD
FUTURE FENCE
TRACK SCALES
CHLORINATION BLDG
INTAKE STRUCTURE
OHIO RIVER
CONDENSER WATER INTAKE
CONTROL BUILDING
SCRUBBER STRUCTURE
POWERHOUSE
EL 345
TRANSFORMER YARD
SWITCHYARD
WATER TREATMENT PLANT
DISCHARGE STRUCTURE
CONVEYOR
CONDENSER WATER OUTLET
WEIR
CRUSHER BUILDING
UTILITY BUILDING
FORMER DISPOSAL POND A
F
E
B
H
G
SLUDGE PONDS
A1
C
D
Disposal Ponds
A1, B, C, D, E, F, G, and H
SCALE 400 0 400 800 FEET

Figure 7. Shawnee steam plant FGD scrubbing test facility sludge ponds location and details

The ponds have been constructed in accordance with the following dimensions (length and width dimensions are to the top of the berm):

Pond	Length, ft	Width, ft	Side Slope	Sludge Depth, ft
A1	10	10	2:3	3
B, E	140	38	2:1	3
C	133	38	2:1	3
D	147	40	2:1	3
G	40	40	2:1	4
H	40	40	2:1	4

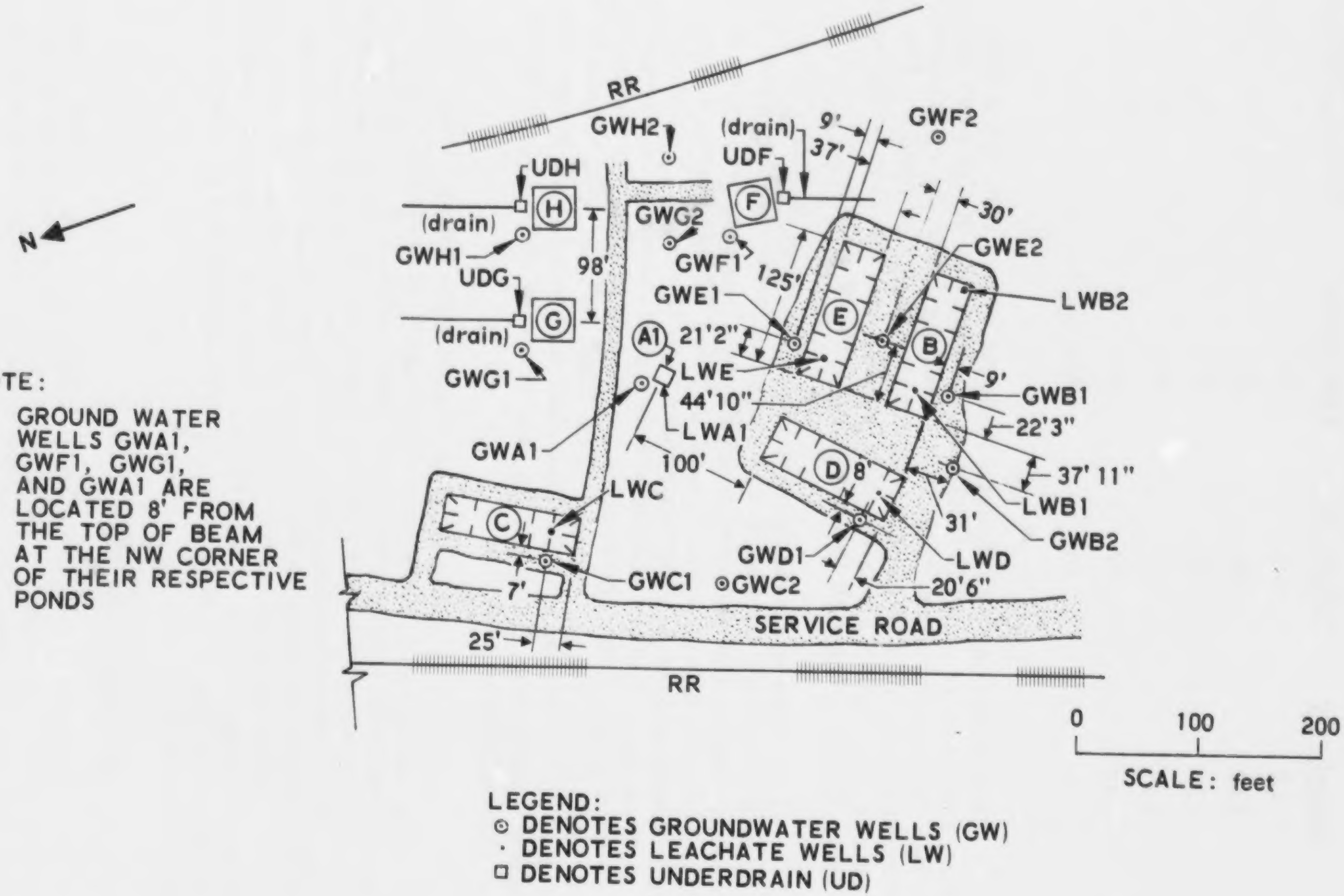
All berms are contoured to drain away from the ponds. No other rain drainage is provided, and no compaction of the pond sides or bottom was performed other than that resulting from the operation of earth-moving equipment incidental to constructing the ponds. The bottom surfaces are generally in a horizontal plane, and the side walls are protected from erosion through the use of limestone rock.

Leachate wells have been constructed in Ponds A1, B, C, D, and E, while Ponds F, G, and H are constructed with underdrain systems. (The leachate wells and underdrain systems are described later in this section.) Access to the leachate well in Pond A1 has been provided by placing a board across the berms adjacent to the well. For each of Ponds B, C, D, and E, a wooden pier has been constructed at one end of the pond to serve as a support for the leachate well and to provide a sampling station for obtaining leachate well water. For Ponds F, G, and H access has been provided to the underdrain collection tank and pump, for inspection and maintenance purposes, through the use of metal steps placed in the concrete liner of the collection pit.

Pond A1 is filled with untreated lime sludge filter cake, Pond D with untreated limestone sludge clarifier underflow, and Pond G with untreated lime sludge centrifuge cake. Ponds B, C, and E are filled with sludge chemically treated by the Dravo Corporation, IU Conversion Systems, Inc., and Chemfix, Inc., respectively. Ponds B and E used limestone sludge clarifier underflow and Pond C used lime sludge centrifuge cake. Although each of the ponded sludges contain fly ash, Pond G contains alternate layers of fly ash and mixtures of fly ash with ash-free lime sludge (Section 7. 1. 2). Pond configurations and nomenclature are shown in Figure 8.

6. 2. 1 Leachate Well Construction

Leachate wells have been constructed on the flat bottom of Ponds A1, B, C, D, and E. The purpose of these wells is to provide water samples that can be analyzed to determine the quality of the water that seeps through the sludge (either untreated or treated) and enters the soil.


RR
GWH2
(drain)
UDF
9'
37'
GWF2
30'
UDH
H
F
(drain)
GWH1
GWG2
GWF1
125'
GWE2
UDG
98'
GWE1
E
B
LWB2
G
(drain)
A1
21'2"
LWE
GWG1
44'10"
9'
GWB1
LWA1
GWA1
22'3"
100'
D
8'
37' 11"
LWB1
LWC
31'
GWB2
C
GWD1
LWD
7'
GWC1
GWC2
20'6"
SERVICE ROAD
25'
RR
N
0
100
200
SCALE: feet
LEGEND:
⊙ DENOTES GROUNDWATER WELLS (GW)
· DENOTES LEACHATE WELLS (LW)
□ DENOTES UNDERDRAIN (UD)

NOTE:

GROUND WATER WELLS GWA1, GWF1, GWG1, AND GWA1 ARE LOCATED 8' FROM THE TOP OF BEAM AT THE NW CORNER OF THEIR RESPECTIVE PONDS

Figure 8. Disposal pond well nomenclature

The well is constructed with a 4-in. -diam plastic pipe implanted as shown in Figure 9. This configuration is to prevent solid material from blocking the entrance to the pipe. The pipe extends approximately 5 feet above the base of the pond. It is anchored to the pier (except for Pond A1) and is covered with a force-fit plastic cap to prevent entry of foreign matter (including rainwater) into the well. The installation is such that surface water cannot freely flow between the sludge and the pipe or through the upper end. The layer of diatomaceous earth is used to filter suspended solids in the leachate.

6.2.2 Underdrain Construction

Underdrain systems have been constructed on the bottoms of Ponds F, G, and H. The purpose of these systems is to remove water which seeps to the pond bottom so that samples can be collected and analyzed for environmental quality, and to permit the sludge to drain so that its structural properties may be tested.

The underdrain systems are constructed with 4-in. -diam plastic pipe implanted in the pond bottom as shown in Figure 10. The collection pipes are drilled on their top halves with 1/8-inch holes on 2-inch centers and have been covered with pea gravel. There is a one-foot layer of sand on top of the pea gravel to filter out particulate matter. The collection pipes are connected to a single gravity drained pipe which flows to a 100-gallon plastic tank. Water is pumped from the collection tank to the surface by a float-operated pump. The water pumped from each pond is metered so that a quantity of water drained can be directly compared to the rainfall measured at the site.

6.2.3 Groundwater Well Construction

A groundwater well has been constructed approximately 100 feet from each pond in the groundwater upstream direction for background water quality measurements. The wells are constructed of either 4- or 6-in. diam plastic pipe, anchored in concrete, packed with clay to prevent seepage down the well shaft, and installed to extend from 3 to 5 feet below the water table. The pipe is covered with a force-fit plastic cover.

Groundwater wells have been constructed on the berms of Ponds B, C, D, and E to measure the quality of groundwater at those locations. These wells are located downstream from the pond relative to the direction of groundwater flow. Newly constructed Ponds F, G, and H do not have groundwater wells installed on the pond berms; a single well to be installed in the downstream direction to monitor these ponds is planned.

6.3 WEATHER DATA STATION

A data-taking station, containing both recording and non-recording instrumentation, has been installed for the purpose of determining weather conditions at the site that may affect the disposal evaluations.

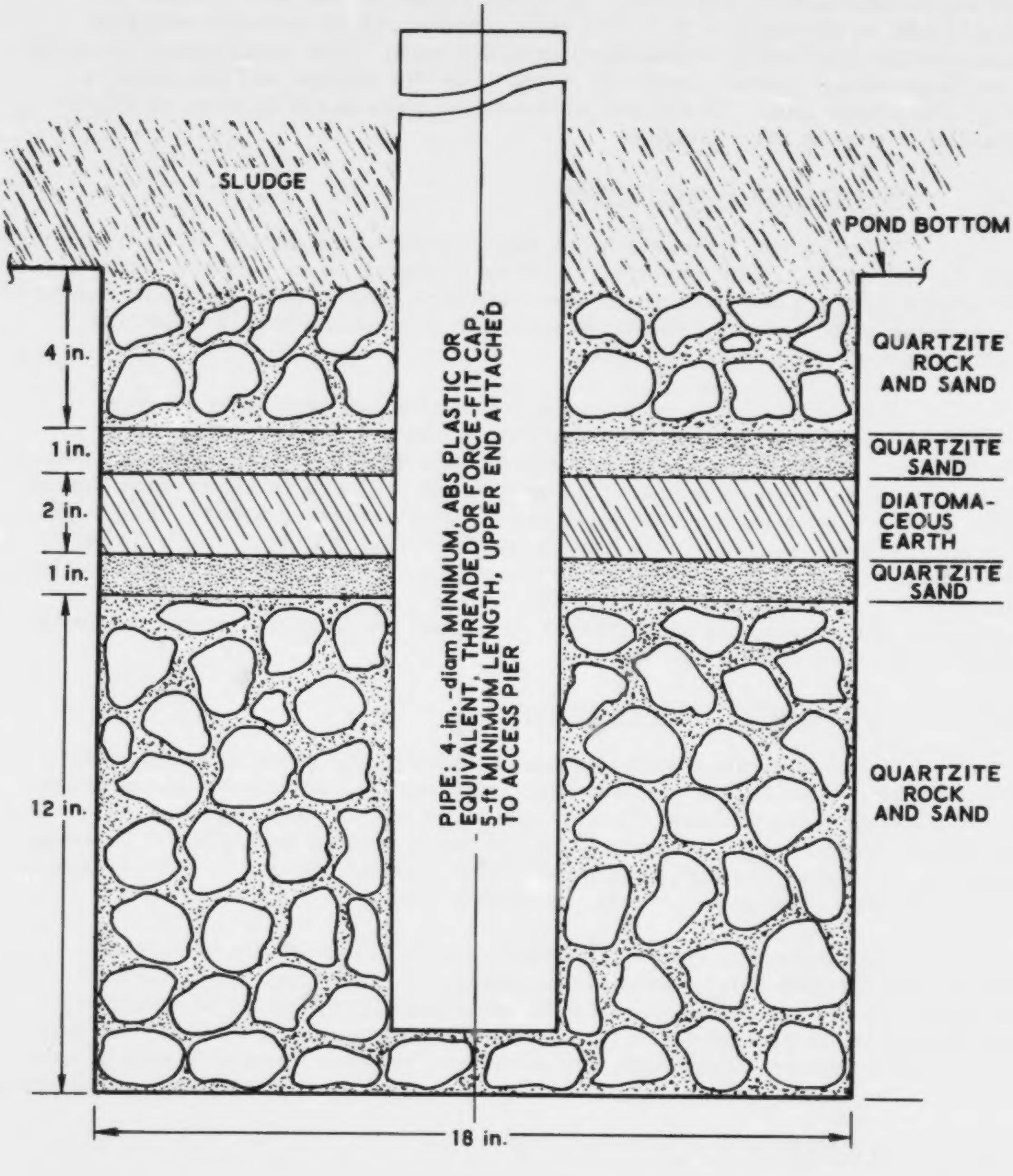

SLUDGE
POND BOTTOM
4 in.
1 in.
2 in.
1 in.
12 in.
18 in.
QUARTZITE ROCK AND SAND
QUARTZITE SAND
DIATOMACEOUS EARTH
QUARTZITE SAND
QUARTZITE ROCK AND SAND
PIPE: 4-in.-diam MINIMUM, ABS PLASTIC OR EQUIVALENT, THREADED OR FORCE-FIT CAP, 5-ft MINIMUM LENGTH, UPPER END ATTACHED TO ACCESS PIER

Figure 9. Leachate collection well

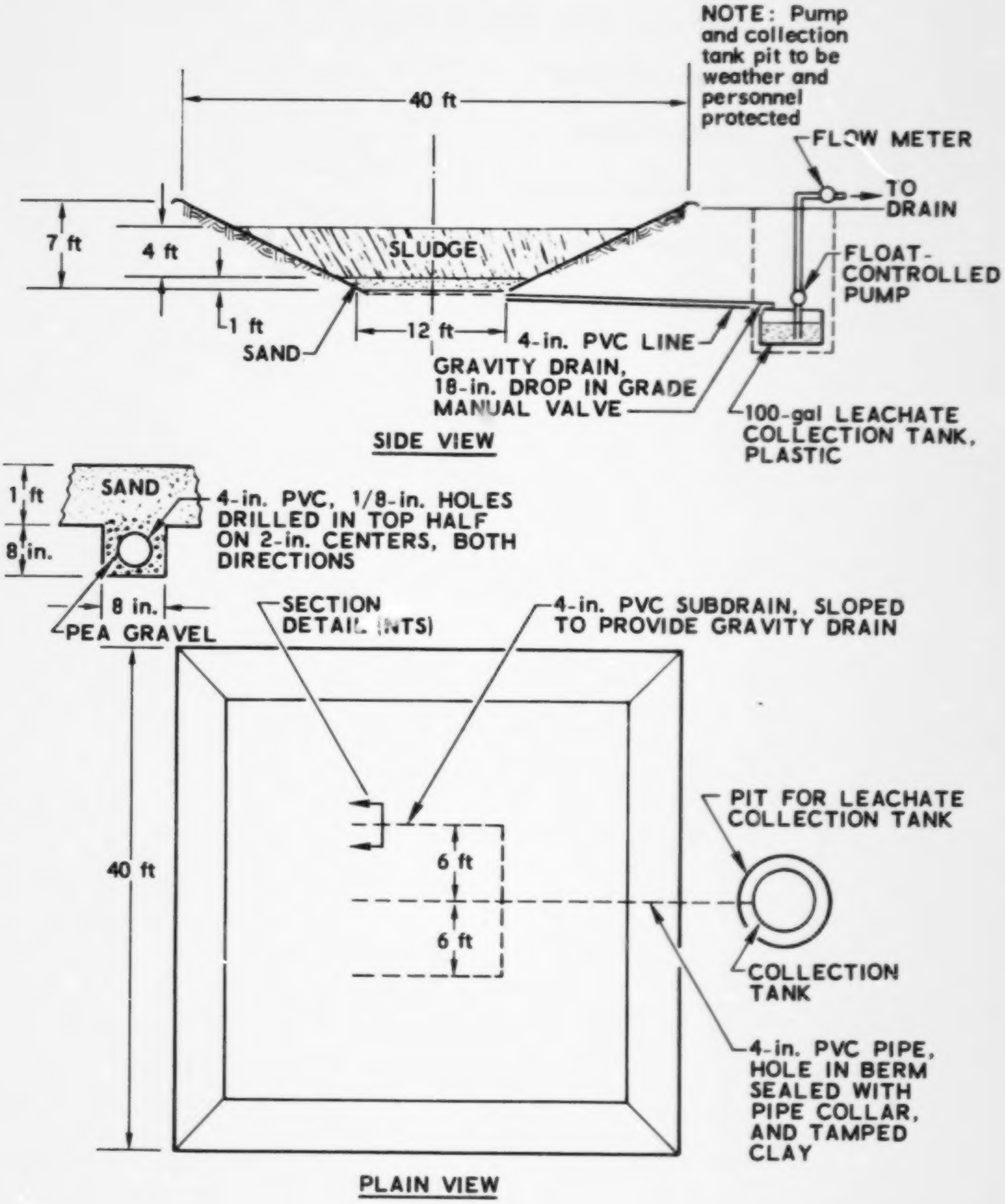

NOTE: Pump and collection tank pit to be weather and personnel protected
40 ft
FLOW METER
TO DRAIN
7 ft
4 ft
SLUDGE
FLOAT-CONTROLLED PUMP
1 ft
12 ft
4-in. PVC LINE
SAND
GRAVITY DRAIN, 18-in. DROP IN GRADE
MANUAL VALVE
100-gal LEACHATE COLLECTION TANK, PLASTIC
SIDE VIEW
1 ft
SAND
4-in. PVC, 1/8-in. HOLES DRILLED IN TOP HALF ON 2-in. CENTERS, BOTH DIRECTIONS
8 in.
8 in.
PEA GRAVEL
SECTION DETAIL (NTS)
4-in. PVC SUBDRAIN, SLOPED TO PROVIDE GRAVITY DRAIN
40 ft
6 ft
6 ft
PIT FOR LEACHATE COLLECTION TANK
COLLECTION TANK
4-in. PVC PIPE, HOLE IN BERM SEALED WITH PIPE COLLAR, AND TAMPED CLAY
PLAIN VIEW

Figure 10. Underdrain system installed in Ponds F and G

Initially, this station was located in the vicinity of Pond A; however, since February 1975, it has been located in the vicinity of Pond D. Measurements made at this station include the following:

a. Air and water temperature

b. Precipitation

c. Evaporation

d. Wind movement

e. Relative humidity

f. Solar radiation

SECTION VII

OPERATIONS AND SCHEDULES

Operations began on this field evaluation program in September 1974, with the completion of construction of the first five disposal ponds, A through E (described in Section 6.2). Pond filling for these initial ponds, for both untreated and treated sludges, was completed by mid-April 1975. Pond A1 was constructed and filled with sludge transferred from the deactivated Pond A in May 1976 (Figures 11 and 12). Three additional ponds, F, G, and H, were constructed in the fall of 1976, and one of these, Pond G, was filled in October 1976. Ponds F and H were filled early in 1977, after the present reporting period. Analyses are being conducted on soils, input sludge, treated sludge, groundwater, leachate, and supernate (as applicable) for all of the filled ponds.

7.1 POND FILLING AND CHEMICAL TREATMENT

The six disposal ponds A1, B, C, D, E, and G were filled with sludges representing a cross section of scrubber effluent conditions. The three ponds filled with untreated sludge (A, D, and G) were selected for evaluation of both lime and limestone scrubbing waste disposal, including ash-free sludge and sludge containing fly ash, drained and undrained ponds, and a variation in the degree of sludge dewatering. The materials used in the evaluation of chemical treatment also represented various disposal operating conditions. Pond B was filled using limestone sludge clarifier underflow chemically treated by Dravo Corporation and placed in the pond under conditions approximating disposal behind a dam. Pond C was filled using lime sludge that had been dewatered by centrifuging, chemically treated by IU Conversion Systems, Inc., and stored in a pond under conditions representing a low spot in a landfill in which rainfall collects. Pond E was filled with limestone sludge clarifier underflow chemically treated by Chemfix, Inc., and placed in the pond under conditions similar to those for Pond C. Details of the pond filling operations for Ponds A through E are described in the initial report on this project (Ref. 1), including processor recommendations on additive quantities for each of the three treatment processes. Descriptions of the two ponds filled during 1976, i.e., A1 and G, are detailed in the following subsections.

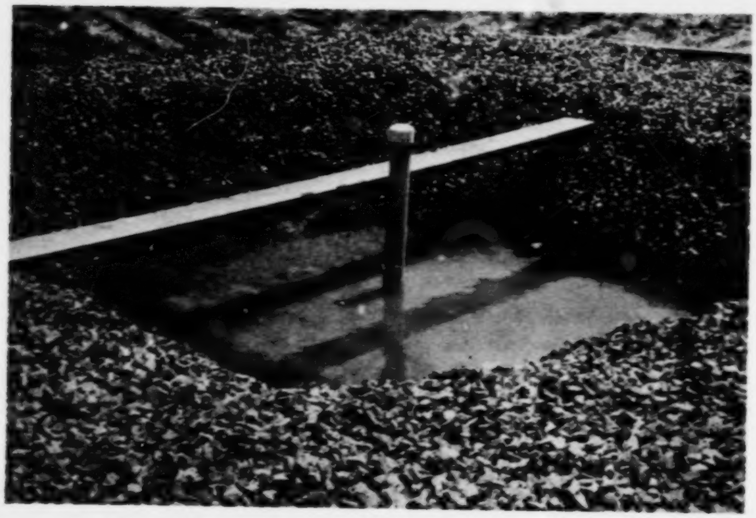


Figure 11. Pond A1, May 1976

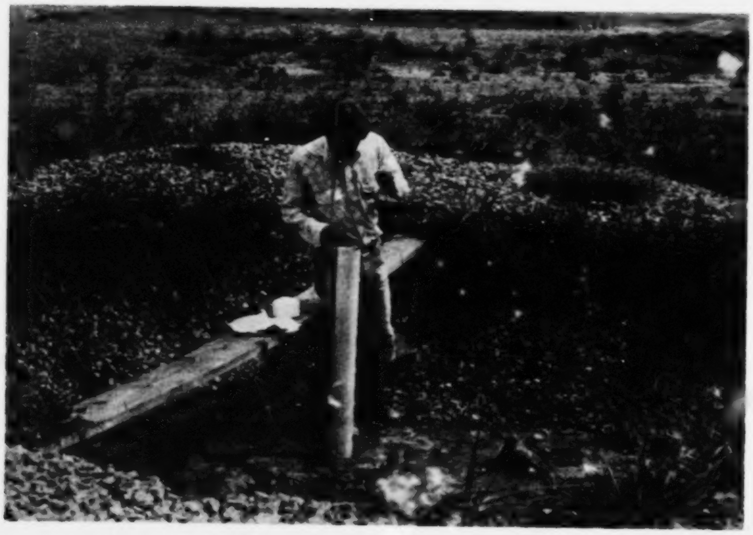


Figure 12. Pond A1, September 1976

7.1.1 Pond A1

The site on which Pond A was located was adjacent to the main coal storage area for the Shawnee power plant. Because of operational needs at the power plant, the coal supply was expanded in April 1976, and it was no longer possible to continue the operation of Pond A. In mid-April, 1100 cu ft of sludge was removed from the pond and stored in 55-gallon drums until a new site could be prepared. The site selected for the new pond, designated Pond A1, is 0.5 miles south of the generating plant, in the vicinity of the other seven ponds. Pond A1 was constructed with 2:3 slopes and equipped with a leachate well at its center. The pond is 10 by 10 feet at the top of the berm and is 6 feet deep. The stored sludge was placed in the pond to a depth of 3 feet on 10 May 1976. Access to the leachate well is provided through the use of a board placed across the berms adjacent to the well. Views of Pond A1 taken in May and September 1976 are shown in Figures 11 and 12.

7.1.2 Pond G

Pond G was filled during the period of 30 September to 5 October 1976 with sludge from the Chemico venturi spray tower scrubber during an ash-free run, using lime as the absorbent. The ash-free sludge was dewatered by centrifuging, mixed with fly ash, and loaded into rotary mix trucks for transport to the pond. The ash-free sludge was obtained from the Bird centrifuge at a solids content of approximately 41 to 42 weight percent and fed by conveyor belt to the concrete mix truck. Fly ash, mixed in a ratio of 2:1 (two parts mechanically collected and one part electrostatic precipitator-collected), was added manually to the centrifuge cake on the conveyor belt, in a quantity equivalent to 20 weight percent of the total solids in the sludge. The trucks were loaded at a rate of approximately 0.9 cu yd/hr. The sludge mix (at a solids content of approximately 45 to 47 weight percent) and layered fly ash were placed in the pond during a single loading operation each day. For each loading sequence, a layer of fly ash (same 2:1 ratio) was placed in the pond, and the sludge was immediately poured over it. The layers of sludge varied in depth from 5.7 to 9 inches, and the fly ash layers ranged between 1.5 and 2.0 inches in depth. A total of six layers, each, of sludge and fly ash was used. As many as three concrete trucks were used in one day, having capacities of 7, 7-1/2, and 9 cu yd, respectively. To fill the pond, a total of approximately 64 cu yd of centrifuge cake was used and a total of 22 cu yd of fly ash. A fly ash layer was put down first on the surface of the sand, and a layer of sludge mix was then placed on the fly ash. Succeeding layers of fly ash and sludge mix were placed in the pond, with the top layer being sludge. Photographs of Pond G taken during and after filling are shown in Figures 13 and 14, and photographs of Ponds B, C, D, and E are shown in Figures 15 through 22.

7.2 SCHEDULES

A schedule for the overall evaluation program and separate schedules for the activities at each pond are shown in Tables 4 through 12. The activities that have been completed are indicated by solid triangles.

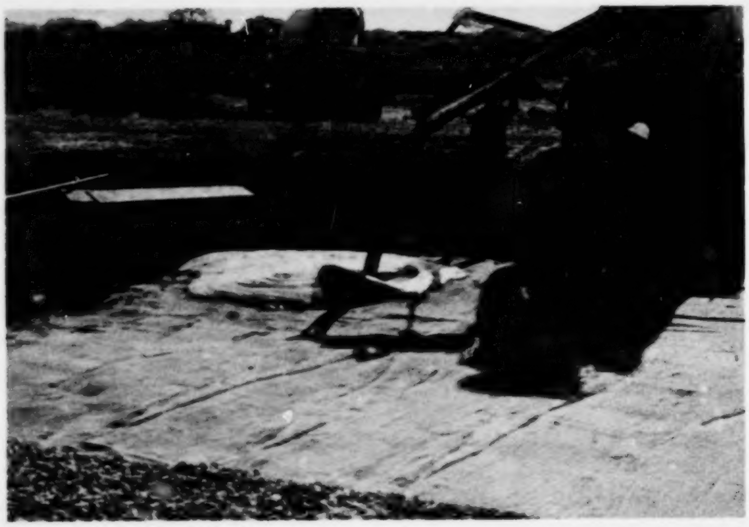


Figure 13. Pond G during filling, October 1976 (sludge being poured on layered fly ash)

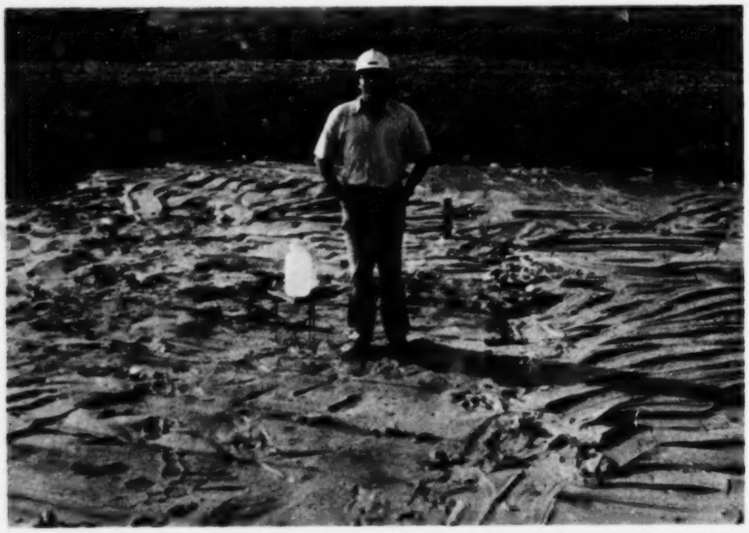


Figure 14. Pond G during filling, October 1976 (photo taken 16 hours after pouring of sludge layer)

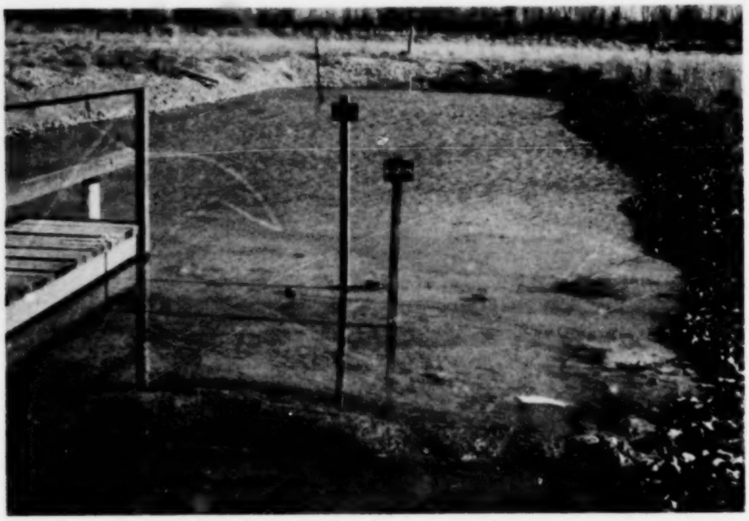


Figure 15. Pond B, December 1975

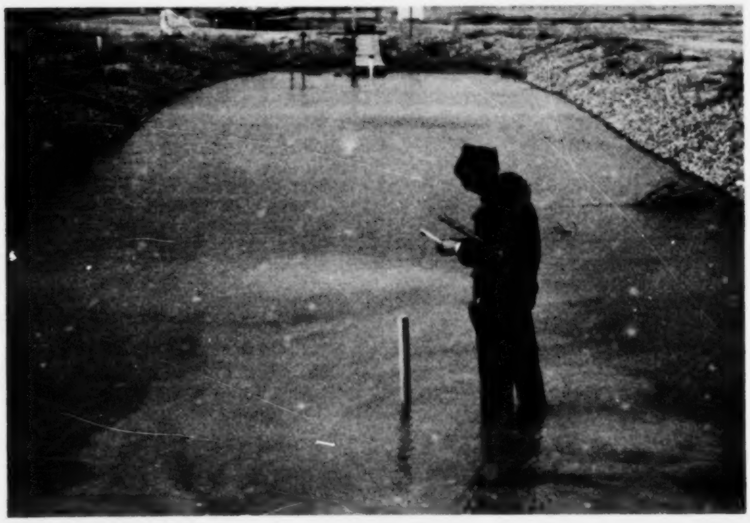


Figure 16. Pond B, May 1976

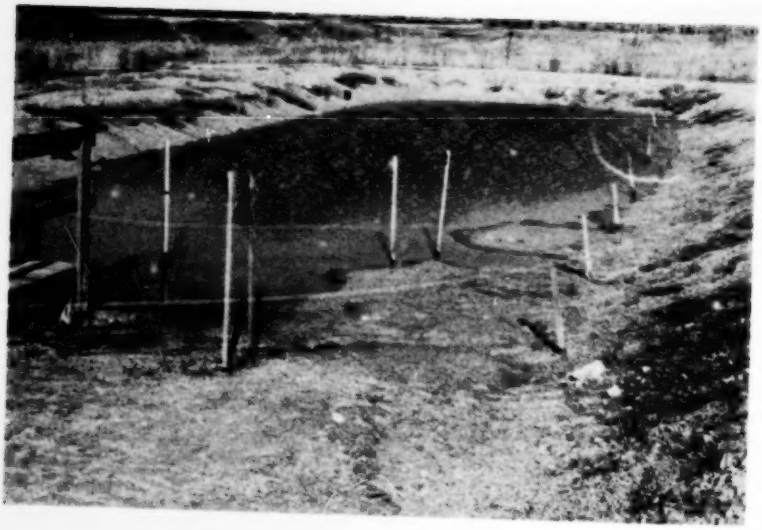


Figure 17. Pond C, December 1975

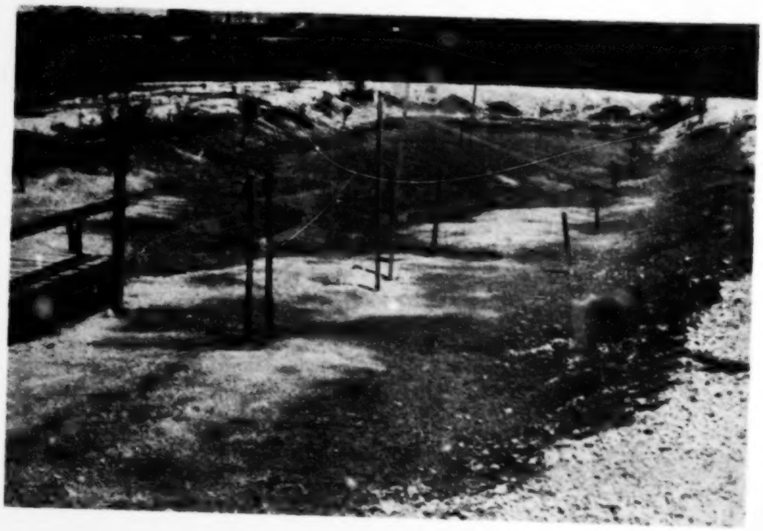


Figure 18. Pond C, May 1976

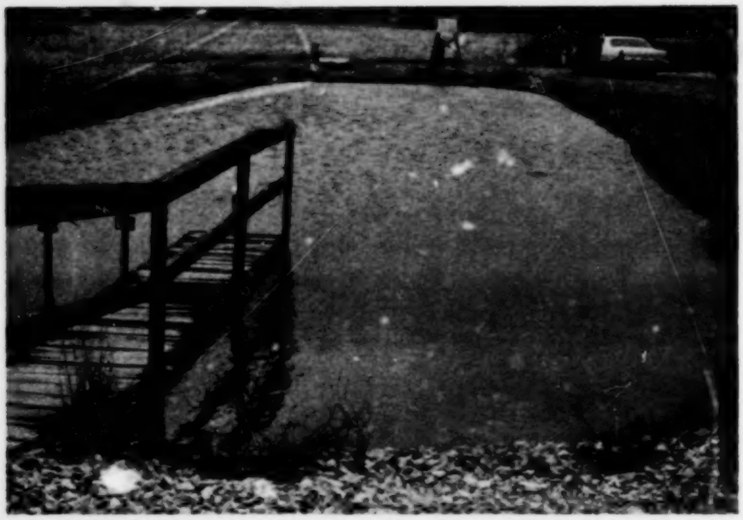


Figure 19. Pond D, December 1975

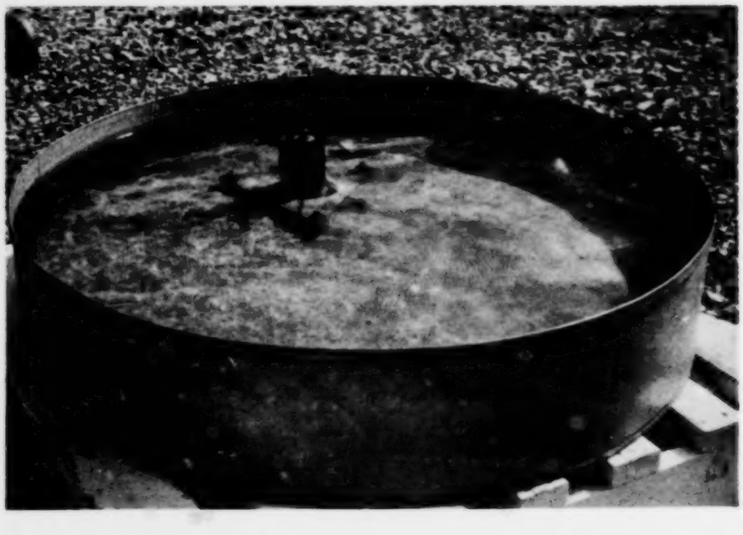


Figure 20. Evaporation pan located adjacent to Pond D, May 1976

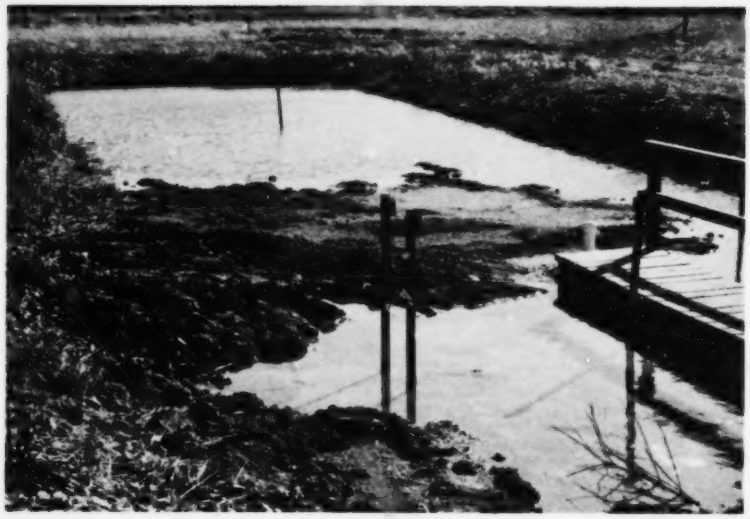


Figure 21. Pond E, December 1975

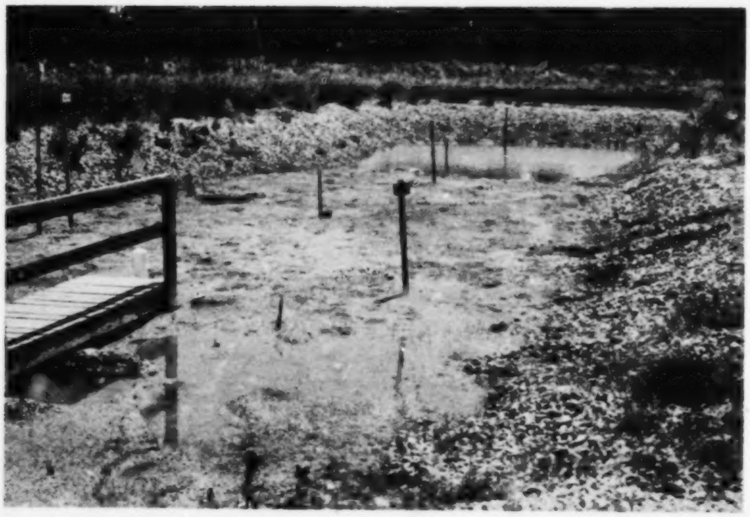


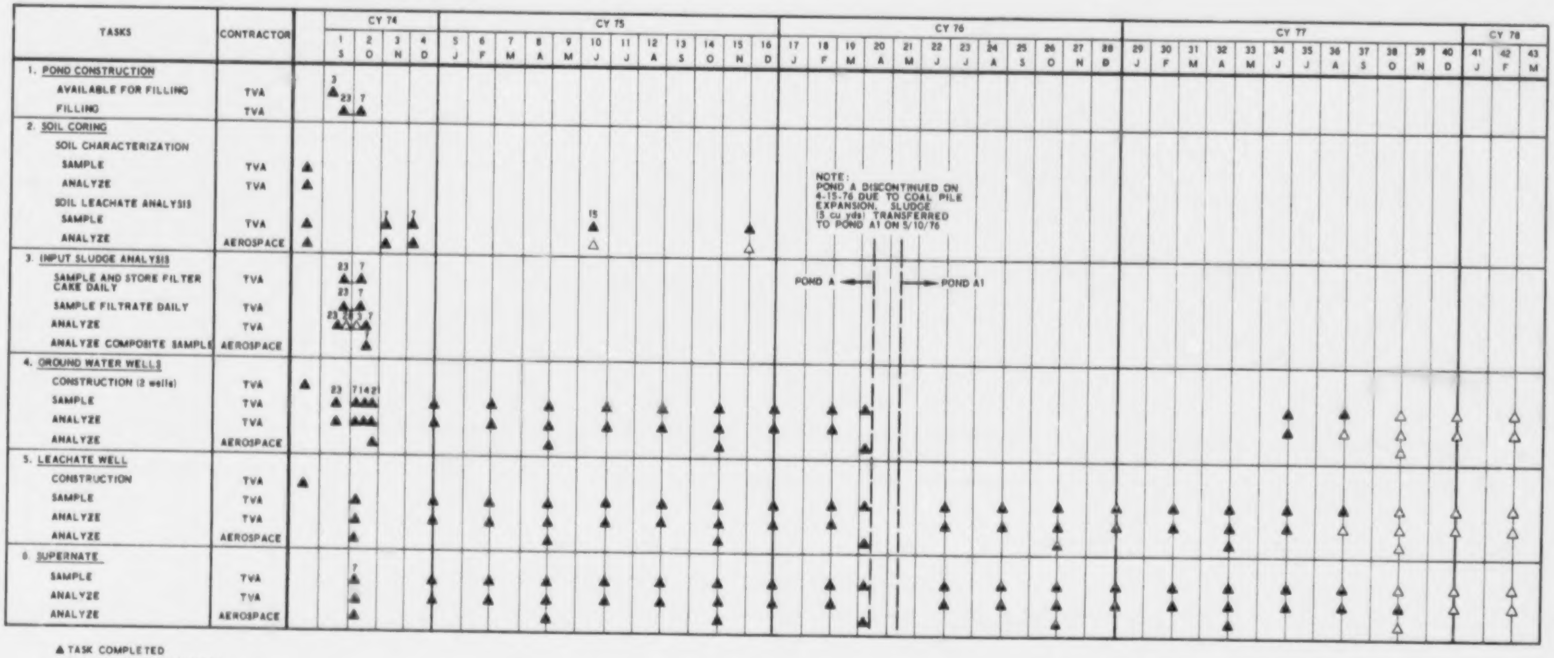
Figure 22. Pond E, May 1976

TABLE 4. GENERAL SCHEDULE: EPA/TVA SHAWNEE SLUDGE DISPOSAL FIELD DEMONSTRATION

TASKS	AGENCIES/ CONTRACTOR	CY 74				CY 75												CY 76												CY 77												CY 78		
		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40	41	42	43
		S	O	N	D	J	F	M	A	M	J	J	A	S	O	N	D	J	F	M	A	M	J	J	A	S	O	N	D	J	F	M	A	M	J	J	A	S	O	N	D	J	F	M
PONDS FILLED																																												
POND A	TVA		7 ▲																																									
POND B	DRAVO (D)								15 ▲																																			
POND C	IUCS (I)								23 ▲																																			
POND D	TVA		20 ▲				5 ▲																																					
POND E	CHEMFIX (C)				7 ▲																																							
PROGRAM REVIEW MEETINGS	EPA/TVA/ AEROSPACE/ BECHTEL		2 ▲			21 ▲			6 ▲			29 ▲		24 ▲					12 ▲				25 ▲			23 ▲					3 ▲					▲				▲		△		
FIXATION REVIEW MEETINGS (1 day for each fixation contractor)	EPA/TVA/ AEROSPACE/ BECHTEL/ FIXATION CONTRACTORS		C 25 ▲	I 6 ▲	DC 3 4 ▲▲				D.I 9 ▲		C. D. I 18, 19, 20 ▲			D 19 ▲		I 20 ▲					D. I 28, 29 ▲			D 28 ▲														▲						
CLIMATOLOGICAL/ HYDRAULIC DATA	TVA	←							COLLECTION AND ANALYSIS																																			→
REPORTING																																												
PHOTOGRAPHIC DOCUMENTATION	TVA	←																																										→
REPORTS																																												
INTERIM																																												
DRAFT	AEROSPACE																▲														▲													
DISTRIBUTE	AEROSPACE																			▲													△											△

▲ TASK COMPLETED
△ TASK TO BE ACCOMPLISHED

TABLE 5. POND A/A1: LIME SLUDGE, FILTER CAKE, UNTREATED; FILL CONTRACTOR, TVA



▲ TASK COMPLETED
△ TASK TO BE ACCOMPLISHED
▲ INSUFFICIENT SAMPLE AVAILABLE
Note: Activity dates do not reflect shipping time

TABLE 6. POND B: LIMESTONE SLUDGE, CLARIFIER UNDERFLOW, TREATED; TREATMENT CONTRACTOR, DRAVO

TASKS	CONTRACTOR	CY 74				CY 75												CY 76												CY 77												CY 78		
		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40	41	42	43
		S	O	N	D	J	F	M	A	M	J	J	A	S	O	N	D	J	F	M	A	M	J	J	A	S	O	N	D	J	F	M	A	M	J	J	A	S	O	N	D	J	F	M
1. POND CONSTRUCTION																																												
AVAILABLE FOR FILLING	TVA		▲																																									
FILLING	DRAVO								7 15 ▲ ▲																																			
2. SOIL CORING																																												
SOIL CHARACTERIZATION																																												
SAMPLE	TVA		▲																																									
ANALYZE	TVA		▲																																									
SOIL LEACHATE ANALYSIS																																												
SAMPLE	TVA		▲				▲			15 ▲	15 ▲							▲						▲								▲						△						
ANALYZE	AEROSPACE			▲			▲			▲	▲							△						△								△						△						
3. INPUT SLUDGE ANALYSIS																																												
SAMPLE CLARIFIER UNDERFLOW DAILY	TVA								7 15 ▲—▲																																			
ANALYZE SEPARATED LIQUOR	TVA								7 10 15 ▲▲▲▲																																			
ANALYZE COMPOSITE % SOLIDS	AEROSPACE								15 ▲																																			
ANALYZE COMPOSITE LIQUOR	AEROSPACE								▲																																			
ANALYZE COMPOSITE DRY SOLIDS	AEROSPACE								▲																																			
4. GROUND WATER WELLS																																												
CONSTRUCTION (2 wells)	TVA		▲																																									
SAMPLE	TVA								7 15 22 28 ▲▲▲▲		▲		▲		▲		▲		▲		▲		▲		▲		▲		▲		▲		▲		▲		△		△		△		△	
ANALYZE	TVA								▲▲▲▲		▲		▲		▲		▲		▲		▲		▲		▲		▲		▲		▲		▲		▲		△		△		△		△	
ANALYZE	AEROSPACE								28 ▲						▲						▲						◭						▲						△					
5. LEACHATE WELL																																												
CONSTRUCTION	TVA		▲																																									
SAMPLE	TVA						11 ▲		15 ▲		▲		▲		▲		▲		▲		▲		▲		▲		▲		▲		▲		▲		▲		△		△		△		△	
ANALYZE	TVA						▲		▲		▲		▲		▲		▲		▲		▲		▲		▲		▲		▲		▲		▲		▲		△		△		△		△	
ANALYZE	AEROSPACE						▲		▲						▲						▲						◭						▲						△					
6. SUPERNATE																																												
SAMPLE	TVA								▲		▲		▲		▲		▲		▲		▲		▲		▲		▲		▲		▲		▲		▲		△		△		△		△	
ANALYZE	TVA								▲		▲		▲		▲		▲		▲		▲		▲		▲		▲		▲		▲		▲		▲		△		△				△	
ANALYZE	AEROSPACE								▲						▲						▲						◭						▲						△					
7. TREATED SLUDGE																																												
INPUT MATERIAL																																												
SAMPLE DAILY	TVA								7 15 ▲—▲																																			
RETAIN FOR CONTINGENCY ANALYSIS	AEROSPACE								▲																																			
CORES																																												
SAMPLE	TVA									15 ▲	15 ▲							▲						▲								▲						△						
ANALYZE	AEROSPACE									▲	▲							▲						△								△						△						

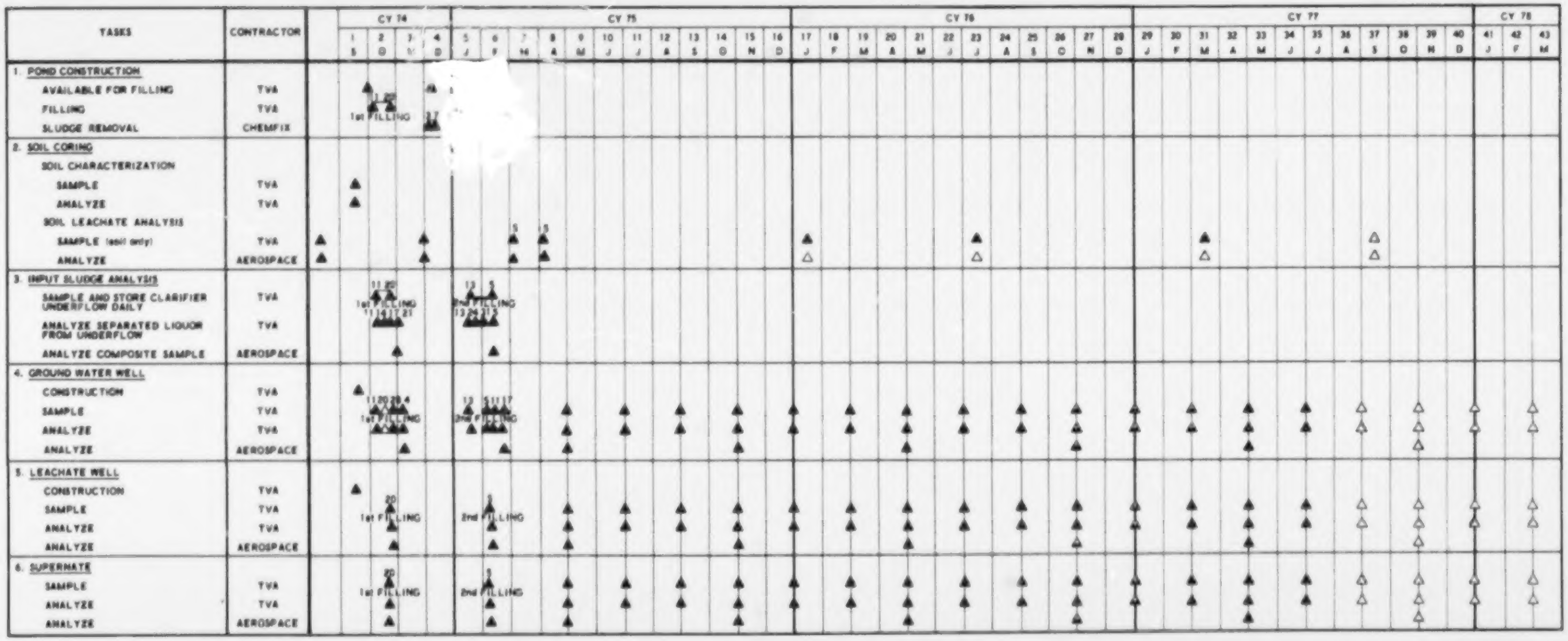
▲ TASK COMPLETED
△ TASK TO BE ACCOMPLISHED
◭ INSUFFICIENT SAMPLE AVAILABLE
Note Activity dates do not reflect shipping time

TABLE 7. POND C: LIME SLUDGE, CENTRIGUGE CAKE, TREATED; TREATMENT CONTRACTOR, IUĈS

TASKS	CONTRACTOR	CY 74				CY 75												CY 76												CY 77												CY 78		
		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40	41	42	43
		S	O	N	D	J	F	M	A	M	J	J	A	S	O	N	D	J	F	M	A	M	J	J	A	S	O	N	D	J	F	M	A	M	J	J	A	S	O	N	D	J	F	M
1. POND CONSTRUCTION																																												
AVAILABLE FOR FILLING	TVA	▲																																										
FILLING	IUCS								1 ▲ 23 ▲																																			
2. SOIL CORING																																												
SOIL CHARACTERIZATION																																												
SAMPLE	TVA		▲																																									
ANALYZE	TVA		▲																																									
SOIL LEACHATE ANALYSIS																																												
SAMPLE	TVA							▲		23 ▲	23 ▲							▲						▲								▲						△						
ANALYZE	AEROSPACE							▲		▲	▲							△						△								▲						△						
3. INPUT UNTREATED SLUDGE ANALYSIS																																												
SAMPLE CAKE DAILY	TVA								1 ▲ 23 ▲																																			
ANALYZE SEPARATED LIQUOR	TVA								1 ▲ 8 ▲ ▲ ▲ 23																																			
ANALYZE COMPOSITE % SOLIDS	AEROSPACE								23 ▲ 15																																			
ANALYZE COMPOSITE LIQUOR	AEROSPACE								▲																																			
ANALYZE COMPOSITE DRY SOLIDS	AEROSPACE								▲																																			
4. GROUND WATER WELLS																																												
CONSTRUCTION (2 wells)	TVA		▲																																									
SAMPLE	TVA								1 ▲ 23 ▲ 30 ▲	7 ▲		▲		▲		▲		▲		▲		▲		▲		▲		▲		▲		▲		▲		▲		△		△		△		△
ANALYZE	TVA								▲ ▲ ▲	▲		▲		▲		▲		▲		▲		▲		▲		▲		▲		▲		▲		▲		▲		△		△		△		△
ANALYZE	AEROSPACE									▲						▲						▲						▲						▲						△				
5. LEACHATE WELL																																												
CONSTRUCTION	TVA		▲																																									
SAMPLE	TVA						11 ▲		23 ▲			▲		▲		▲		▲		▲		▲		▲		▲		▲		▲		▲		▲		▲		△		△		△		△
ANALYZE	TVA						▲		▲			▲		▲		▲		▲		▲		▲		▲		▲		▲		▲		▲		▲		▲		△		△		△		△
ANALYZE	AEROSPACE						▲		▲							▲						▲						▲						▲						△				
6. SUPERNATE																																												
SAMPLE	TVA								▲			▲		▲		▲		▲		▲		▲		▲		▲		▲		▲		▲		▲		▲		△		△		△		△
ANALYZE	TVA								▲			▲		▲		▲		▲		▲		▲		▲		▲		▲		▲		▲		▲		▲		△		△		△		△
ANALYZE	AEROSPACE								▲							▲						▲						▲						▲						△				
7. TREATED SLUDGE																																												
INPUT MATERIAL																																												
SAMPLE DAILY	TVA								1 ▲ 23 ▲																																			
RETAIN FOR CONTINGENCY ANALYSIS	AEROSPACE								▲																																			
CORES																																												
SAMPLE	TVA									23 ▲	23 ▲							▲						▲								▲						△						
ANALYZE	AEROSPACE									▲	▲							▲						△								▲						△						

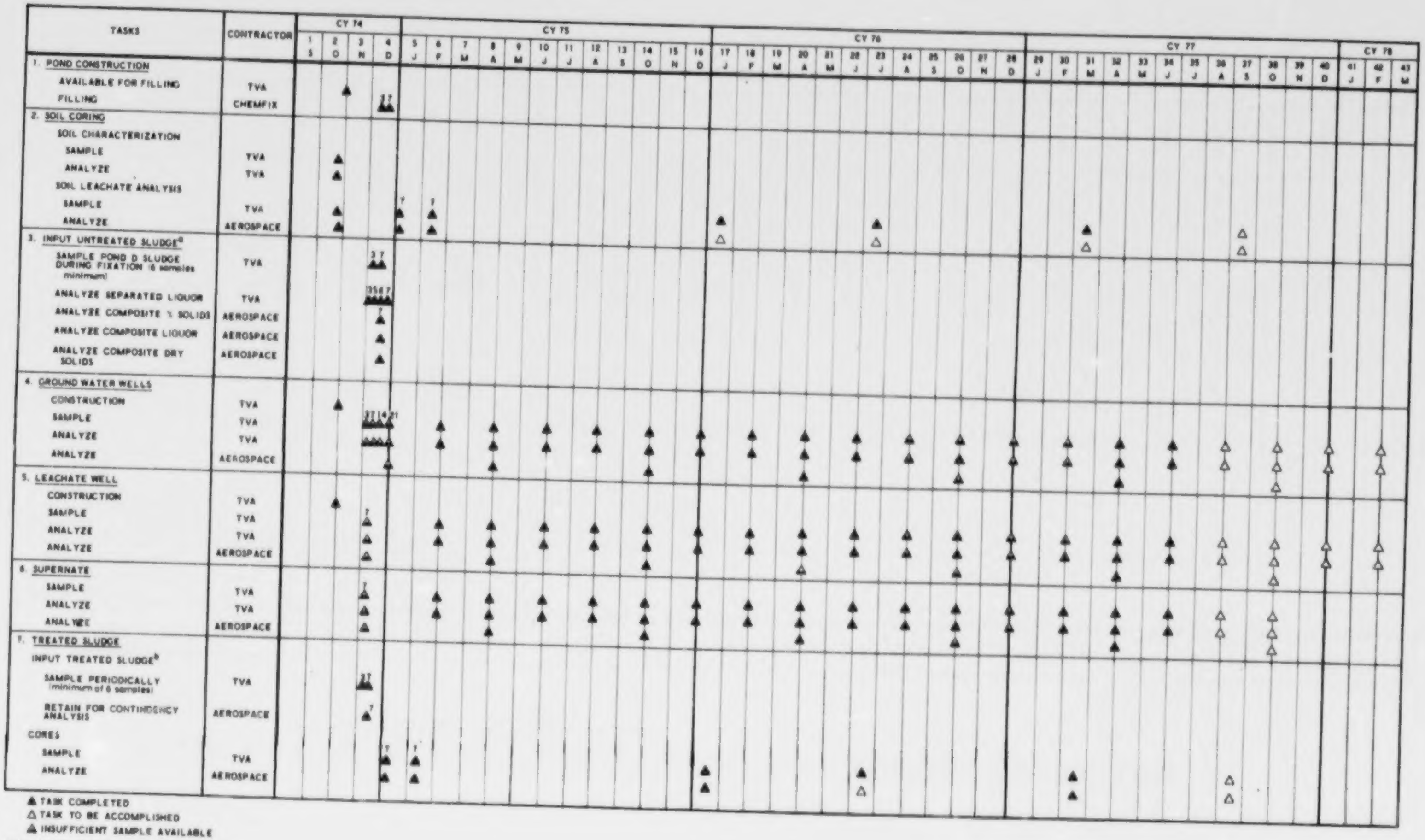
▲ TASK COMPLETED
△ TASK TO BE ACCOMPLISHED
▲ INSUFFICIENT SAMPLE AVAILABLE
Note: Activity dates do not reflect shipping time

TABLE 8. POND D: LIMESTONE, CLARIFIER UNDERFLOW, UNTREATED; FILL CONTRACTOR, TVA



▲ TASK COMPLETED
△ TASK TO BE ACCOMPLISHED
▲ INSUFFICIENT SAMPLE AVAILABLE
Note: Activity dates do not reflect shipping time

TABLE 9. POND E: LIMESTONE, CLARIFIER UNDERFLOW, TREATED; TREATMENT CONTRACTOR, CHEMFIX



▲ TASK COMPLETED

△ TASK TO BE ACCOMPLISHED

▲ INSUFFICIENT SAMPLE AVAILABLE

Note: Activity dates do not reflect shipping time
a. Input to Chemfix trailer
b. Chemfix trailer input to Pond E

TABLE 10. POND F: LIMESTONE, CLARIFIER UNDERFLOW, UNTREATED; FILL CONTRACTOR, TVA

TASKS	CONTRACTOR	CY 76						CY 77												CY 78		
		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21
		J	A	S	O	N	D	J	F	M	A	M	J	J	A	S	O	N	D	J	F	M
1. POND CONSTRUCTION																						
AVAILABLE FOR FILLING	TVA		▲																			
FILLING	TVA							28 ▲	3 ▲													
2. SOIL CORING																						
SOIL CHARACTERIZATION																						
SAMPLE	TVA	7 ▲																				
ANALYZE	TVA		27 ▲																			
SOIL LEACHATE ANALYSIS																						
SAMPLE (soil only)	TVA	7 ▲																				
ANALYZE	AEROSPACE				△																	
3. INPUT SLUDGE ANALYSIS																						
SAMPLE AND STORE CLARIFIER UNDERFLOW DAILY	TVA							28 ▲	3 ▲													
ANALYZE SEPARATED LIQUOR FROM UNDERFLOW	TVA									▲												
ANALYZE COMPOSITE SAMPLE	AEROSPACE									△												
4. GROUND WATER WELL																						
CONSTRUCTION	TVA									▲												
SAMPLE	TVA										▲		▲		▲		△		△		△	
ANALYZE	TVA										▲		▲		△		△		△		△	
ANALYZE	AEROSPACE										▲						△					
5. UNDERDRAIN SYSTEM																						
CONSTRUCTION	TVA		▲																			
SAMPLE	TVA							28 ▲	4 ▲ ▲		▲		▲		▲		△		△		△	
ANALYZE	TVA								▲		▲		▲		△		△		△		△	
ANALYZE	AEROSPACE										▲						△					

▲ TASK COMPLETED

△ TASK TO BE ACCOMPLISHED

Note: Activity dates do not reflect shipping time

TABLE 11. POND G: LIME, CENTRIFUGE CAKE, UNTREATED; FILL CONTRACTOR, TVA

TASKS	CONTRACTOR	CY 76						CY 77											
		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18
		J	A	S	O	N	D	J	F	M	A	M	J	J	A	S	O	N	D
1. POND CONSTRUCTION																			
AVAILABLE FOR FILLING	TVA		▲																
FILLING	TVA			30 ▲	5 ▲														
2. SOIL CORING																			
SOIL CHARACTERIZATION																			
SAMPLE	TVA	7 ▲																	
ANALYZE	TVA		27 ▲																
SOIL LEACHATE ANALYSIS																			
SAMPLE (soil only)	TVA	7 ▲																	
ANALYZE	AEROSPACE				△														
3. INPUT SLUDGE ANALYSIS																			
SAMPLE AND STORE CENTRIFUGE CAKE DAILY	TVA			30 ▲	5 ▲														
ANALYZE SEPARATED LIQUOR FROM CENTRIFUGE CAKE	TVA					▲													
ANALYZE COMPOSITE SAMPLE	AEROSPACE					△													
4. GROUND WATER WELL																			
CONSTRUCTION	TVA	7 ▲																	
SAMPLE	TVA		20 ▲	▲		▲		▲		▲		▲		▲		△		△	△
ANALYZE	TVA		▲	▲		▲		▲		▲		▲		▲		△		△	△
ANALYZE	AEROSPACE					◬						▲							
5. UNDERDRAIN SYSTEM																			
CONSTRUCTION	TVA		▲																
SAMPLE	TVA			30 ▲	5 ▲	◬		◬		△		▲		▲		△		△	△
ANALYZE	TVA				▲	◬		◬		△		▲		▲		△		△	△
ANALYZE	AEROSPACE					◬						▲						△	

▲ TASK COMPLETED
△ TASK TO BE ACCOMPLISHED
◬ INSUFFICIENT SAMPLE AVAILABLE
Note: Activity dates do not reflect shipping time

TABLE 12. POND H: LIMESTONE, OXIDIZED SULFITE, CLARIFIER UNDERFLOW AND FILTER CAKE, UNTREATED; FILL CONTRACTOR, TVA

TASKS	CONTRACTOR	CY 76						CY 77												CY 78		
		1 J	2 A	3 S	4 O	5 N	6 D	7 J	8 F	9 M	10 A	11 M	12 J	13 J	14 A	15 S	16 O	17 N	18 D	19 J	20 F	21 M
1. POND CONSTRUCTION																						
AVAILABLE FOR FILLING	TVA					▲																
FILLING	TVA														18 ▲	30 ▲						
2. SOIL CORING																						
SOIL CHARACTERIZATION																						
SAMPLE	TVA	7 ▲																				
ANALYZE	TVA		27 ▲																			
SOIL LEACHATE ANALYSIS																						
SAMPLE (soil only)	TVA	7 ▲																				
ANALYZE	AEROSPACE													▲								
3. INPUT SLUDGE ANALYSIS																						
SAMPLE AND STORE DAILY	TVA														18 ▲	30 ▲						
ANALYZE SEPARATED LIQUOR	TVA																	△				
ANALYZE COMPOSITE SAMPLE	AEROSPACE																	△				
4. GROUND WATER WELL																						
CONSTRUCTION	TVA																					
SAMPLE	TVA			▲		◬		◬		▲		▲		▲		▲		△		△		△
ANALYZE	TVA			▲		◬		◬		▲		▲		▲		△		△		△		△
ANALYZE	AEROSPACE					◬						▲						△				
5. UNDERDRAIN SYSTEM																						
CONSTRUCTION	TVA														▲							
SAMPLE	TVA															▲		△		△		△
ANALYZE	TVA															△		△		△		△
ANALYZE	AEROSPACE																	△				

▲ TASK COMPLETED
△ TASK TO BE ACCOMPLISHED
◬ INSUFFICIENT SAMPLE AVAILABLE
Note: Activity dates do not reflect shipping time

7.3 SAMPLING AND ANALYSIS

In order to evaluate the environmental acceptability of storing FGD wastes in ponds, periodic monitoring and analysis of pond liquors, groundwater, sludge, and soil were performed. As indicated on the schedules presented in Tables 4 through 12, the program requires bimonthly sampling and analysis of groundwater, leachate, and supernate. The groundwater associated with the ponds is sampled from wells in two typical locations, i. e., from background wells in the vicinity of the ponds and from wells located adjacent to the ponds. The leachate or underdrainage, as appropriate, from each pond is monitored for major constituents (e. g., calcium, sulfate, sulfite, chloride, and total dissolved solids), as well as pH and trace elements considered potentially objectionable in public water supplies. Pond supernate is also monitored for the same items.

In addition, core samples are obtained semiannually of the soil at the bottom of the ponds and of the sludge in the three ponds which contain treated material. The chemically treated sludge core samples are analyzed for both physical and chemical characteristics (Section 8. 3.), and the soil samples are analyzed to determine the concentration of major constituents (Section 8. 4). The core samples are obtained using a hydraulically powered drill rig and 4-in.-diam steel coring tubes. Since January 1976, the coring tubes for Ponds C and E have been equipped with cutting teeth and are rotated while being pressed into the hardened sludge material. The samples from the other ponds are obtained using nonrotating smooth-edge coring tubes. Prior to use of the sharpened, rotating coring tool, all samples were obtained by means of the smooth-edged tool.

In one instance, at the time of the original coring of the chemically treated ponds (May 1975), the coring crew could not drive the smooth-edged tool through the treated sludge and therefore used a backhoe to reach the region of the sludge-soil interface in Ponds B and C. In November 1975, it was observed that the leachate well in Pond B refilled rapidly after the leachate samples were obtained, and it was assumed that the backhoe operation had set up a direct path from the supernate to the well; however, the actual cause of the quick refilling could not definitely be established. A second leachate well was constructed at the east end of Pond B (LWB2) in May 1976, and samples were obtained from both leachate wells, starting in July 1976. The new leachate well has performed satisfactorily since its installation.

Although the backhoe coring pit in Pond C was refilled and compacted, there was concern over the effects of the coring operation. However, subsequent tests indicate that there is no direct path from the coring pit to the leachate well. In addition, these tests also indicate that there are alternate paths for rainwater to reach the leachate well other than through the disruption caused by the coring operation. These alternate paths apparently consist of vertical and lateral cracks in the sludge material probably caused by less than optimum compaction and formation of shrinkage cracks during curing. These conditions can be minimized in full-scale applications (Section 4. 5. 1).

Figure 23. Drilling rig used for core sampling

Figure 24. Drill bit and pipe used for groundwater well construction and soil sampling

Figure 25. Soil coring sample taken during groundwater well construction

Figure 26. Closeup of soil core sample

Pond A1 has not been soil-cored because of possible damage to the leachate well in the restricted space at the bottom of this small pond, and Pond G will not be cored until a sufficient evaluation has been made of the underdrain system. Photographs of soil core sampling operations are shown in Figures 23 through 26.

During the filling of each of the ponds, the input material was sampled and the liquid portion analyzed for the parameters in Table 13. The results of the analyses of pond input liquors are shown in Appendix B. A description of the sampling for each pond is given in Reference 1. The input materials for Pond G were sampled during filling, but the results of analyses were not available by the end of October and will be presented in the next report.

Once each year, a full chemical characterization is performed on the leachate from each pond. The results of the first of these analyses, performed on samples obtained in January 1976, are shown in Appendix B.

Table 13. WATER ANALYSIS PARAMETERS[a]

Arsenic	Chloride
Boron	Sulfate
Calcium	Sulfite[b]
Lead	Conductance, mmho/cm
Magnesium	Total Dissolved Solids (TDS)
Mercury	pH
Selenium	Chemical Oxygen Demand (COD)
Total Alkalinity	Sodium

[a] Concentration: mg/ℓ unless otherwise indicated.

[b] Applies to analyses of pond input liquors only.

SECTION VIII

RESULTS OF ANALYSES

8.1 UNTREATED SLUDGE

8.1.1 Pond A/A1 Water Analyses

Groundwater at the site of Pond A was monitored periodically by means of two wells. Leachate was collected periodically from a well located below the floor of the pond, and supernate was sampled from the surface of the pond. Analysis of each of these water sources was made bimonthly by the Tennessee Valley Authority (TVA) and semiannually by The Aerospace Corporation. The concentrations of the three major constituents of sludge liquor (calcium, sulfate, and chloride) and the total dissolved solids (TDS) measured in the water from both groundwater wells, the supernate, and the leachate have been plotted as functions of the time after pond filling in Figures 27, 28, and 29. In April 1976, Pond A was eliminated because of interference with coal storage requirements. Some of the Pond A sludge was transferred to the site of the other ponds and was impounded in a new pond designated A1 (Figure 7). The last plotted data points for supernate (Figure 28) and leachate (Figure 29) were obtained for samples taken from Pond A1.

The two groundwater wells were monitored for periods of 11 and 32 weeks prior to the filling of the pond. Groundwater well GWA1, which was monitored earlier than GWA2, usually showed higher concentrations of constituents and higher TDS. However, the differences usually were not great, and occasional reversals of the levels were observed; hence, the data for both wells have been plotted together without distinction in Figure 27. The only discernible trend in the data is an apparent decrease in the TDS level in each well near the end of the monitoring period. There are no indications of increases in concentration levels that could be attributed to the pond.

The concentrations of TDS and major constituents in the supernate in Pond A/A1 are plotted in Figure 28. These values decrease with time from initial levels which are characteristic of the pond input liquor. In late 1975, the concentrations increased, presumably as a result of increased water evaporation from the supernate caused by the dry seasonal

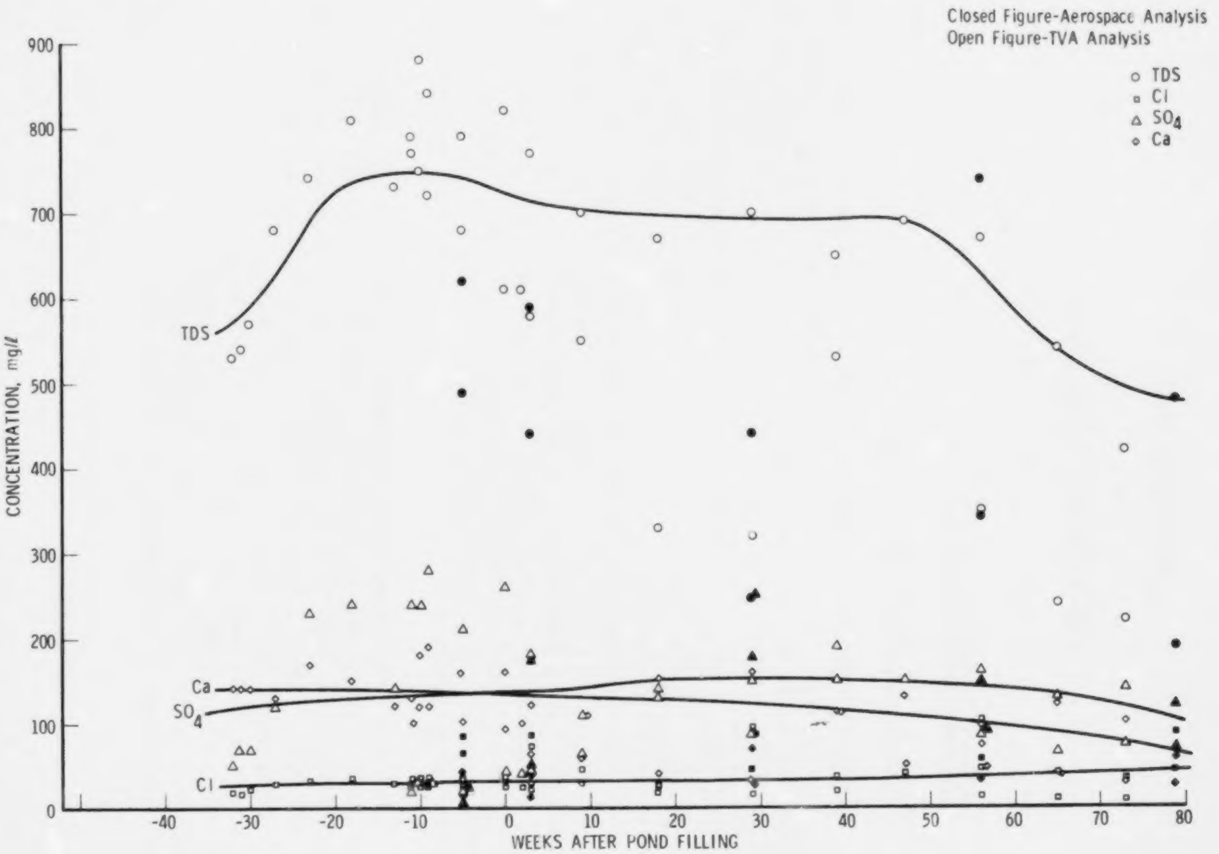


Figure 27. Concentrations of TDS and major species in Pond A groundwater

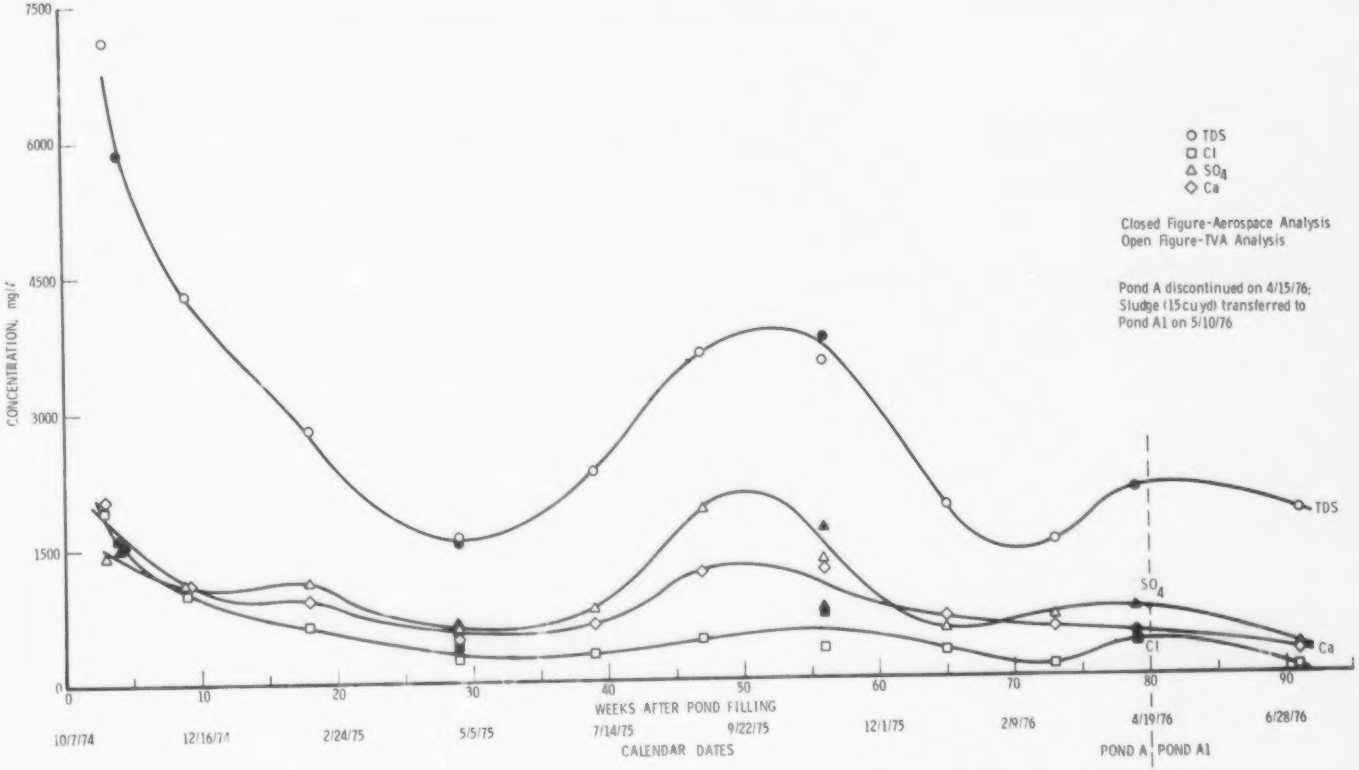


Figure 28. Concentrations of TDS and major species in Pond A/A1 supernate

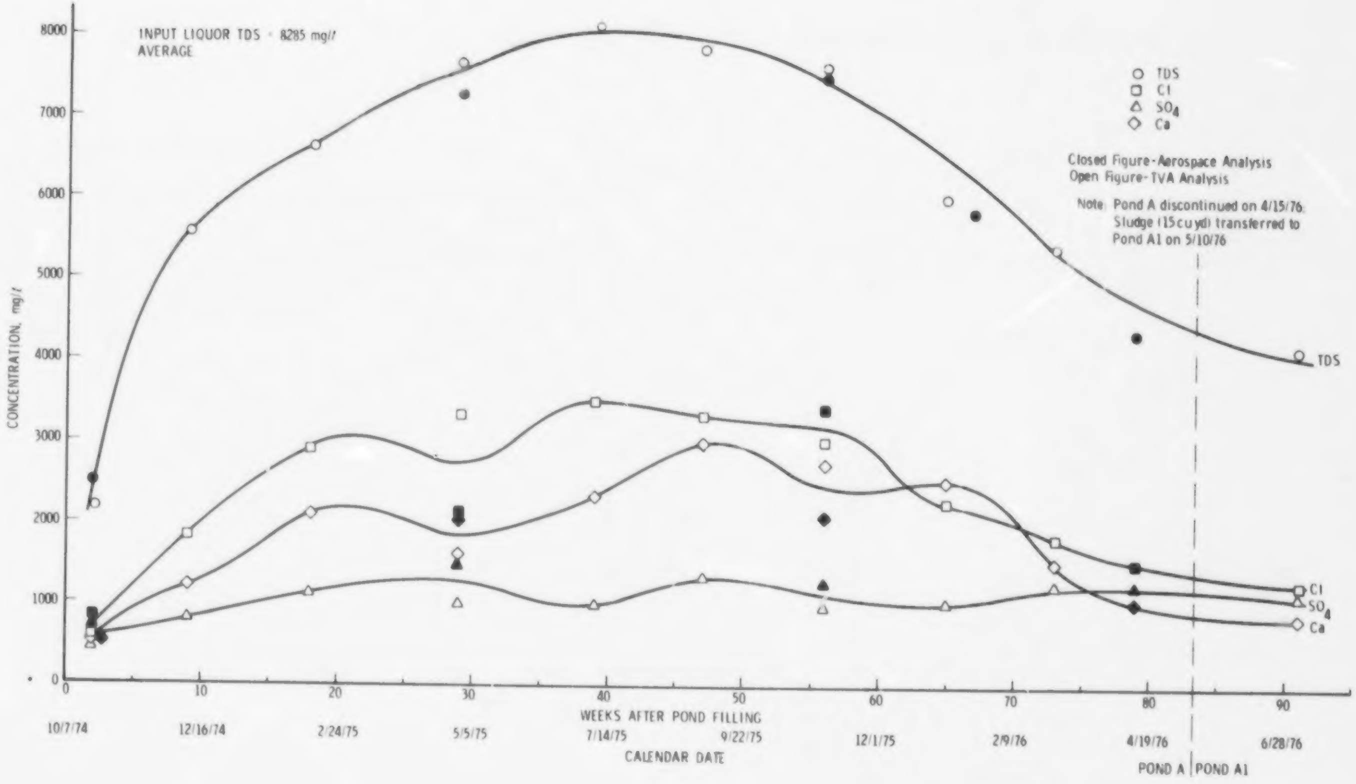


Figure 29. Concentrations of TDS and major species in Pond A/A1 leachate

climate. A similar fluctuation appears near the end of the period monitored.

As shown in Figure 29, the concentrations of major constituents in the leachate of Pond A/A1 increased with time from low values (when the pond was filled and contained rainwater in the region of the leachate well) to maximum values that are comparable to those in the pond input liquor. With the exception of the sulfate concentration, which remained relatively constant, the levels of the major constituents were decreasing with time when the pond was retired. From analyses of the single sample of leachate taken at the new pond location, LWA1, in July 1976, it appears that the trends are continuing.

In Figure 30, the concentrations of magnesium and boron and four trace elements in the leachate of Pond A/A1 have been plotted vs time after pond filling. The concentrations of all six minor constituents, which span a range of six orders of magnitude, are relatively constant over most of the period monitored. Only for the three highest level elements, magnesium, boron, and lead, is there evidence that the concentrations increased from lower initial values to the stable levels characteristic of the remainder of the period monitored. For mercury, the concentration level appears to be decreasing slightly with time, while for arsenic and selenium there may be slightly increasing concentration levels toward the end of the period monitored. The scatter of the data makes assessments of trends for these elements rather unreliable. Furthermore, the transfer of sludge to another location and the construction of a new leachate well add to the uncertainty of the last data points.

8.1.2 Pond D Water Analyses

Pond D was filled twice. Most of the material from the first filling was removed, chemically treated by Chemfix, and transferred to Pond E. In Figure 31, the concentrations of TDS and major constituents in GWD, the single groundwater well associated with Pond D, have been plotted as functions of time after the first filling of the pond. Although the concentrations of calcium and sulfate in the groundwater remained constant during the period monitored, the concentration of chloride and the TDS increased. During this period, the fact that calcium and sulfate concentrations were low and constant and the chloride concentration in the leachate decreased indicates that the increase of chloride and TDS concentration levels in the groundwater was not a consequence of the pond.

The TDS and the concentrations of the major constituents in the supernate of Pond D change with time as shown by the plots of Figure 32. Initial decreases are observed from the values measured immediately after the first pond filling, which correspond to those reported for the pond input sludge liquor. Following this, seasonal variations are observed in which the concentrations increase during hot dry weather as a result of net water loss by evaporation and decrease again when cooler weather and increased rainfall cause additional dilution.

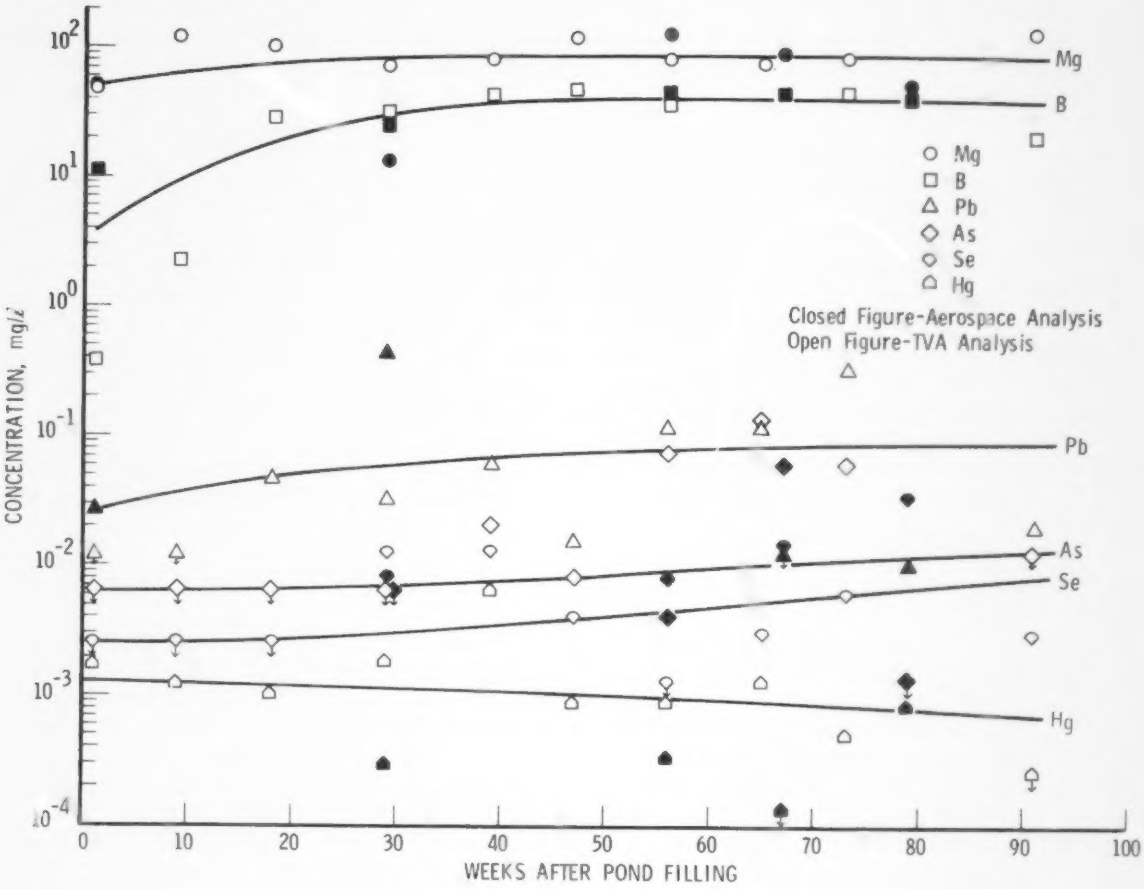


Figure 30. Concentrations of minor species in Pond A leachate

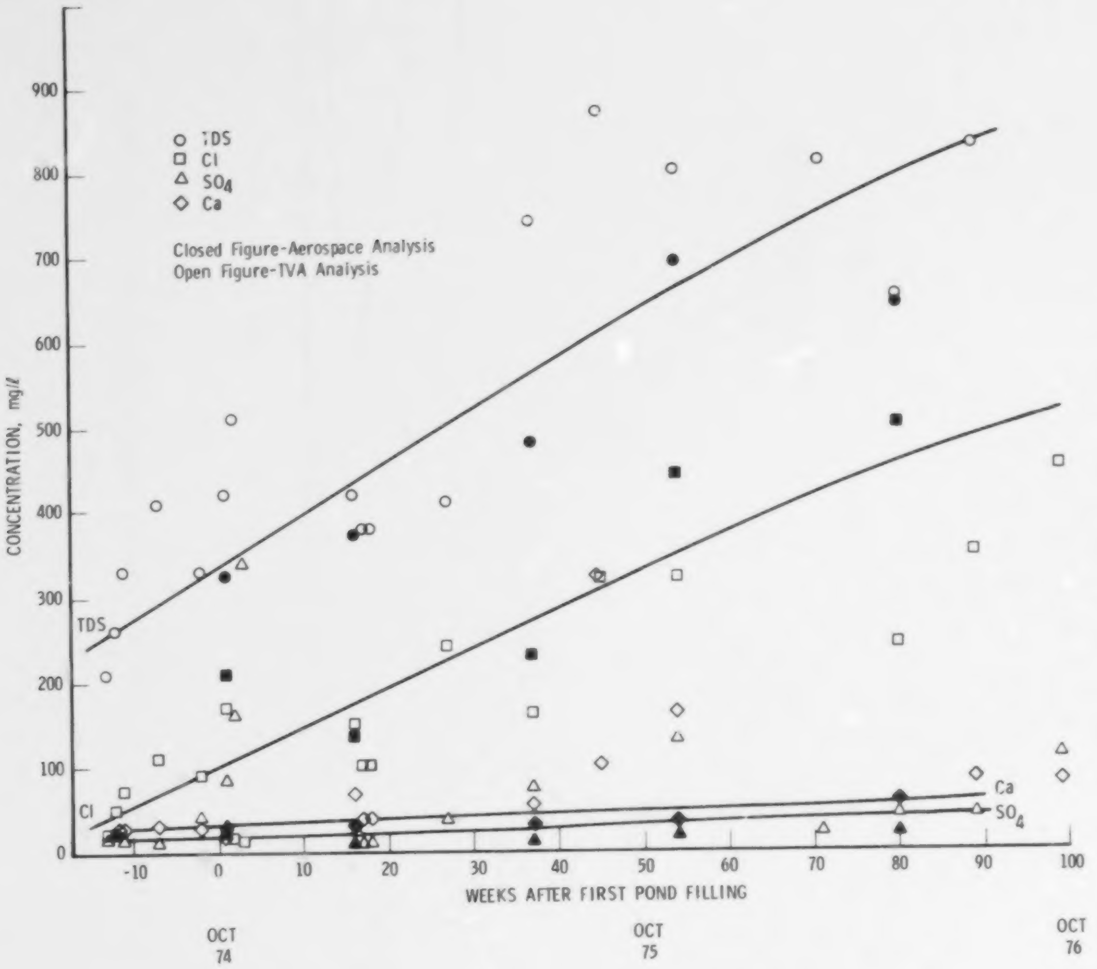


Figure 31. Concentrations of TDS and major species in Pond D groundwater

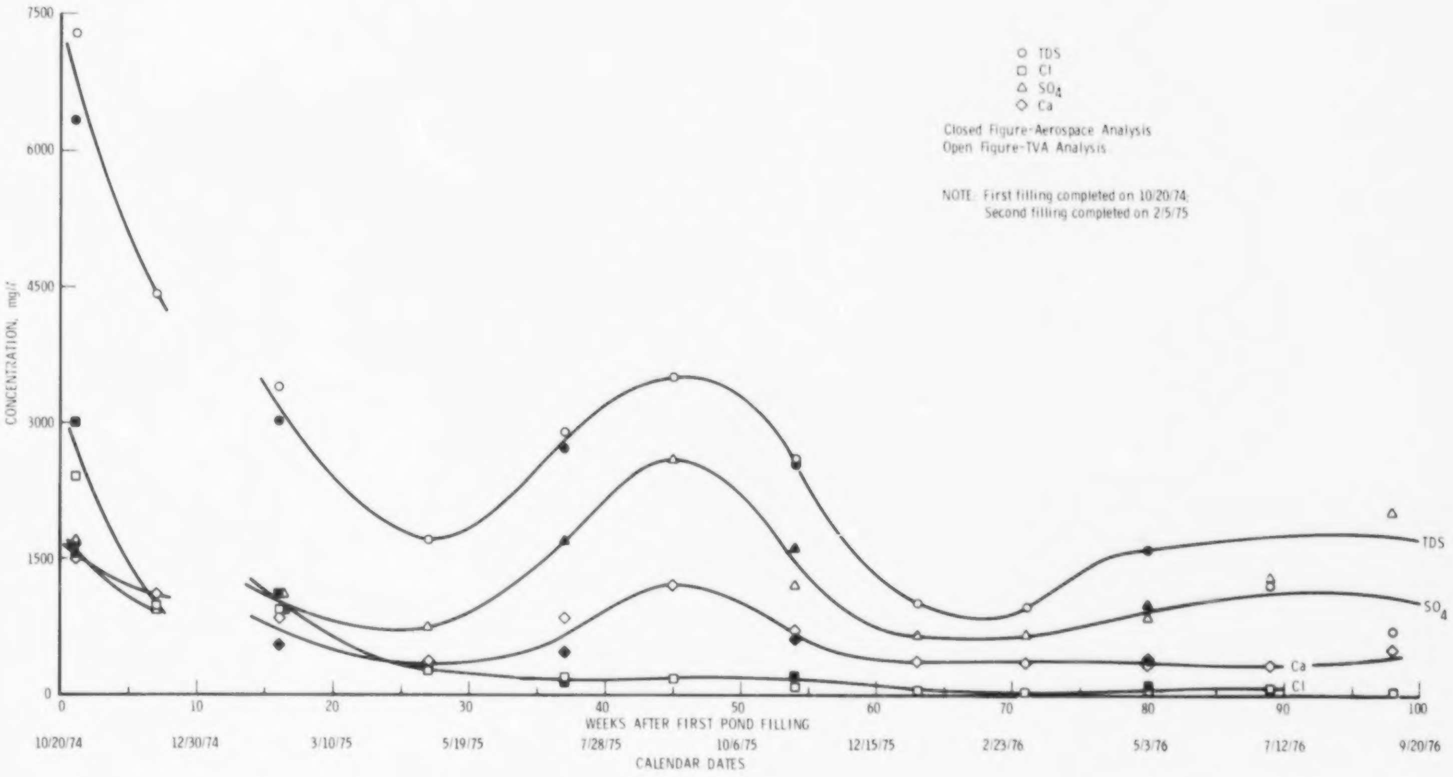


Figure 32. Concentrations of TDS and major species in Pond D supernate

The composition of the leachate from Pond D as a function of time is shown by the plots of Figure 33. The concentrations of the major constituents and the TDS increase rapidly immediately after the first pond filling, reflecting the dilution effect of rainwater in the well area, and continue to rise at a greatly reduced rate following the second filling. Starting in midsummer of 1975, the concentrations of chloride and TDS begin to decrease, while the concentrations of calcium and sulfate remain relatively constant. There is some evidence of seasonally related fluctuations in concentrations, particularly near the end of the period monitored. A similar pattern of variation with time is shown by the concentrations of the six minor constituents of the leachate from Pond D. These data have been plotted as a function of time after the second filling of the pond (Figure 34). The seasonally related variations are apparent for each of the six elements, but for mercury the measured values are just above the detection limits (2×10^{-4} mg/ℓ) so that conclusions regarding fluctuations of the data with time are not very reliable.

8.2 TREATED SLUDGE

8.2.1 Pond B Water Analyses

Pond B was filled in April 1975 with sludge which had been chemically treated by Dravo. One of the two groundwater wells associated with the pond had been monitored for 22 weeks prior to pond filling. The concentrations of the major constituents and TDS were constant during the period monitored, as shown by the plots of Figure 35. The composition of the supernate immediately after pond filling corresponds to that of the pond input sludge. The concentrations of the major constituents and TDS decreased rapidly after pond filling, as shown in Figure 36, but increased during the hot, dry seasons and decreased again when cooler weather and greater rainfall brought about greater dilution of the supernate constituents. The same constituents of the leachate showed an initial rapid rise in concentration after pond filling showing the dilution effects of rainwater in the well area and then tapered off in the spring of 1976 as shown by the plots of Figure 37. The concentrations of major constituents and TDS subsequently increased after the new well (LWB2) was installed in May 1976. The concentrations of the six minor species, however, remained relatively constant throughout the entire period monitored, as shown by the plots of Figure 38.

8.2.2 Pond C Water Analyses

Pond C was filled in April 1975 with sludge chemically treated by IUCS. The groundwater wells associated with the pond were monitored for a period of about 38 weeks prior to the filling of the pond. Except for minor fluctuations after pond filling, particularly for the sulfate concentration, the concentrations of major species and TDS were relatively constant over the period monitored (Figure 39). In contrast, the concentrations of the major constituents and TDS in the pond supernate varied widely during the period monitored, as shown by the plots of Figure 40. The maxima in the curves correspond to dry seasonal periods when the supernate receded so that only a small portion of the surface of the pond was

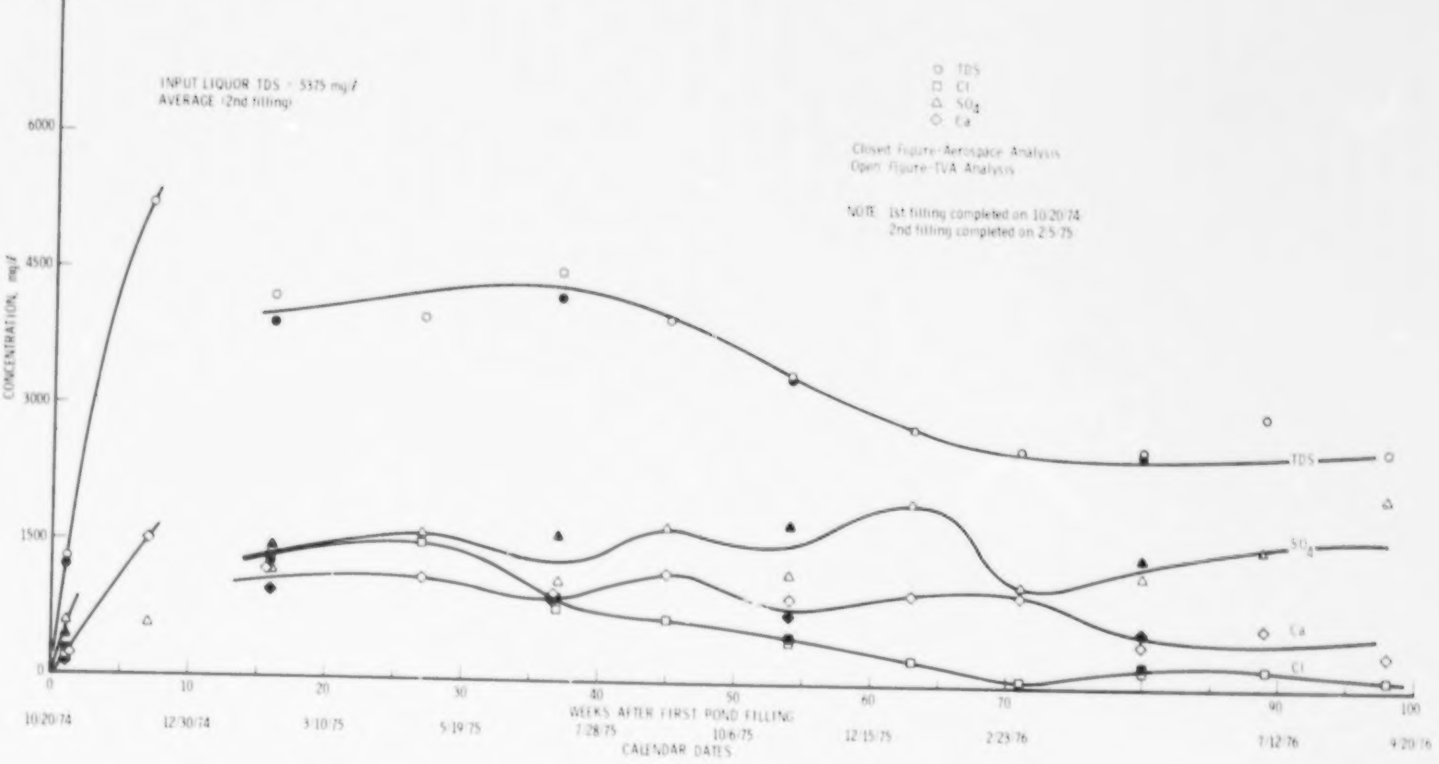


Figure 33. Concentrations of TDS and major species in Pond D leachate

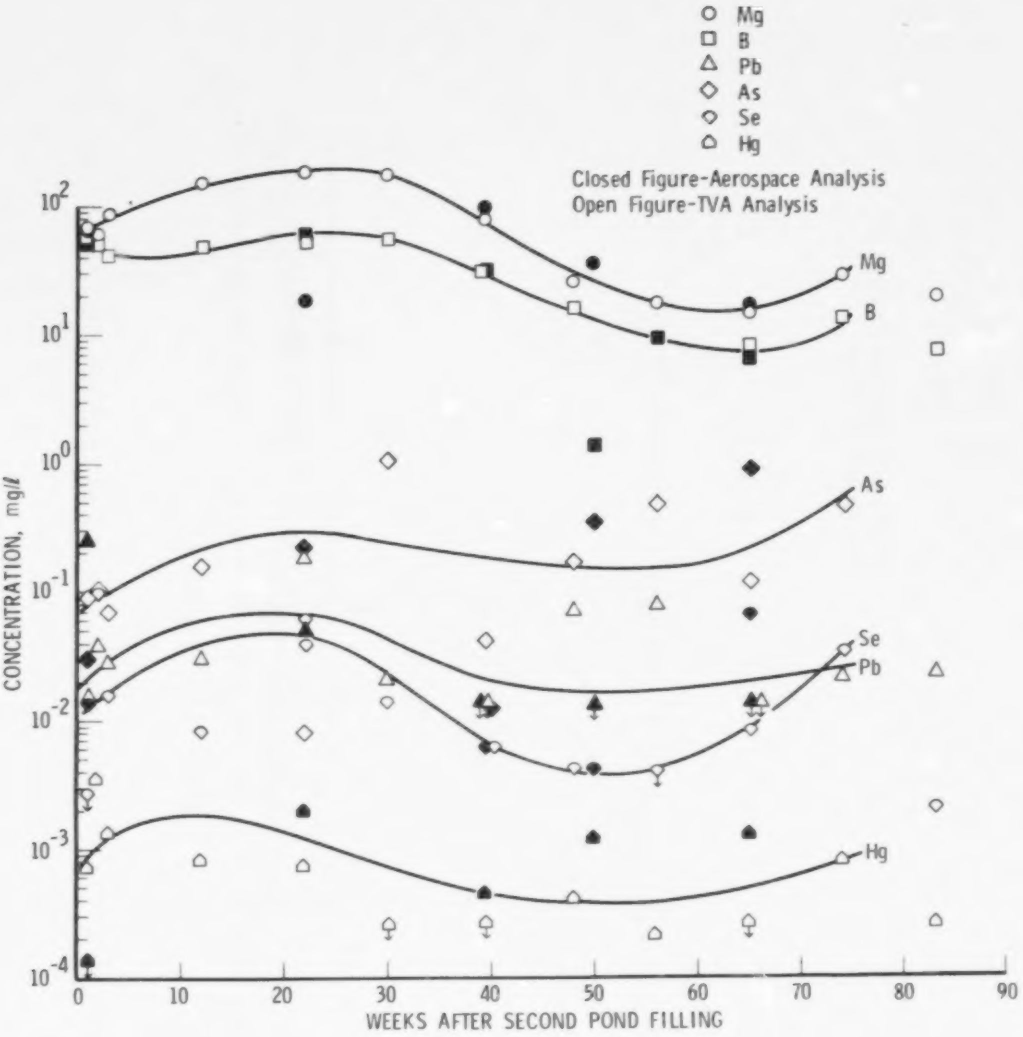


Figure 34. Concentrations of minor species in Pond D leachate

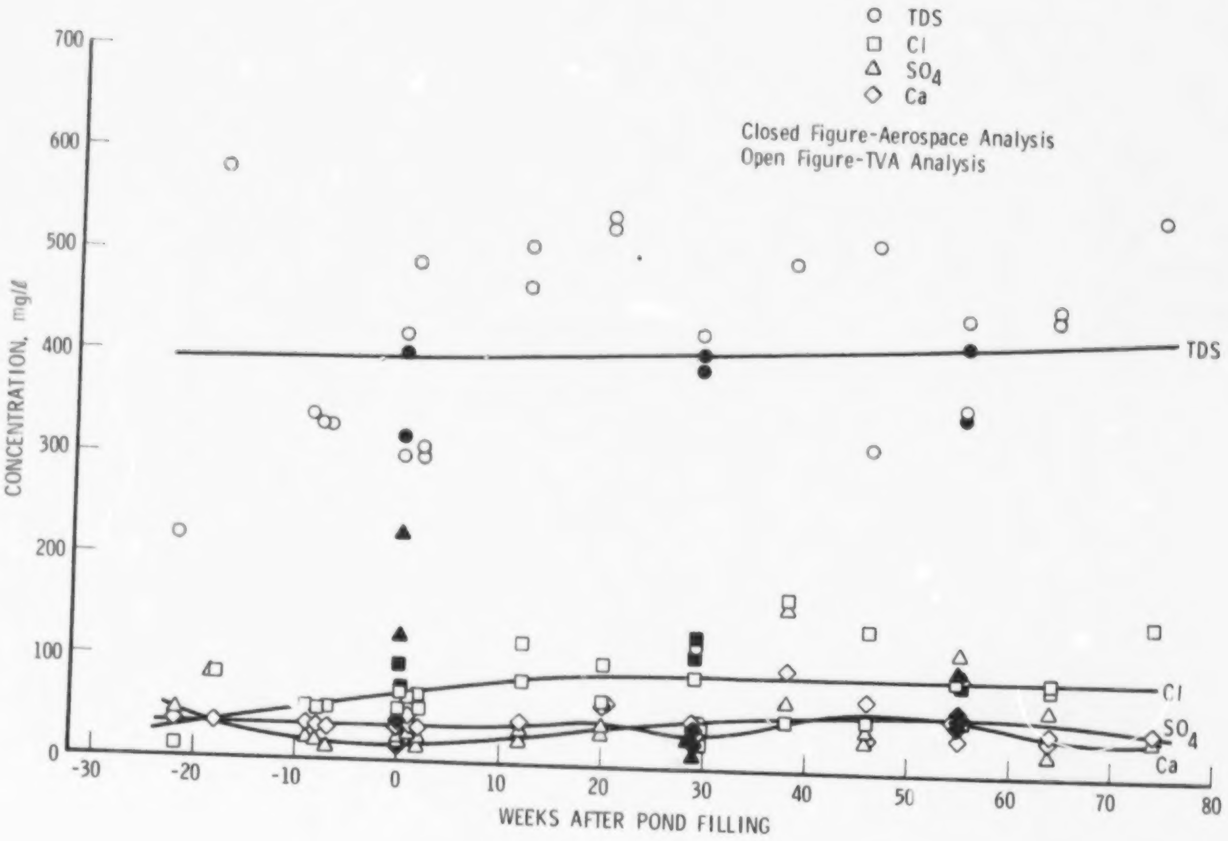


Figure 35. Concentrations of TDS and major species in Pond B groundwater

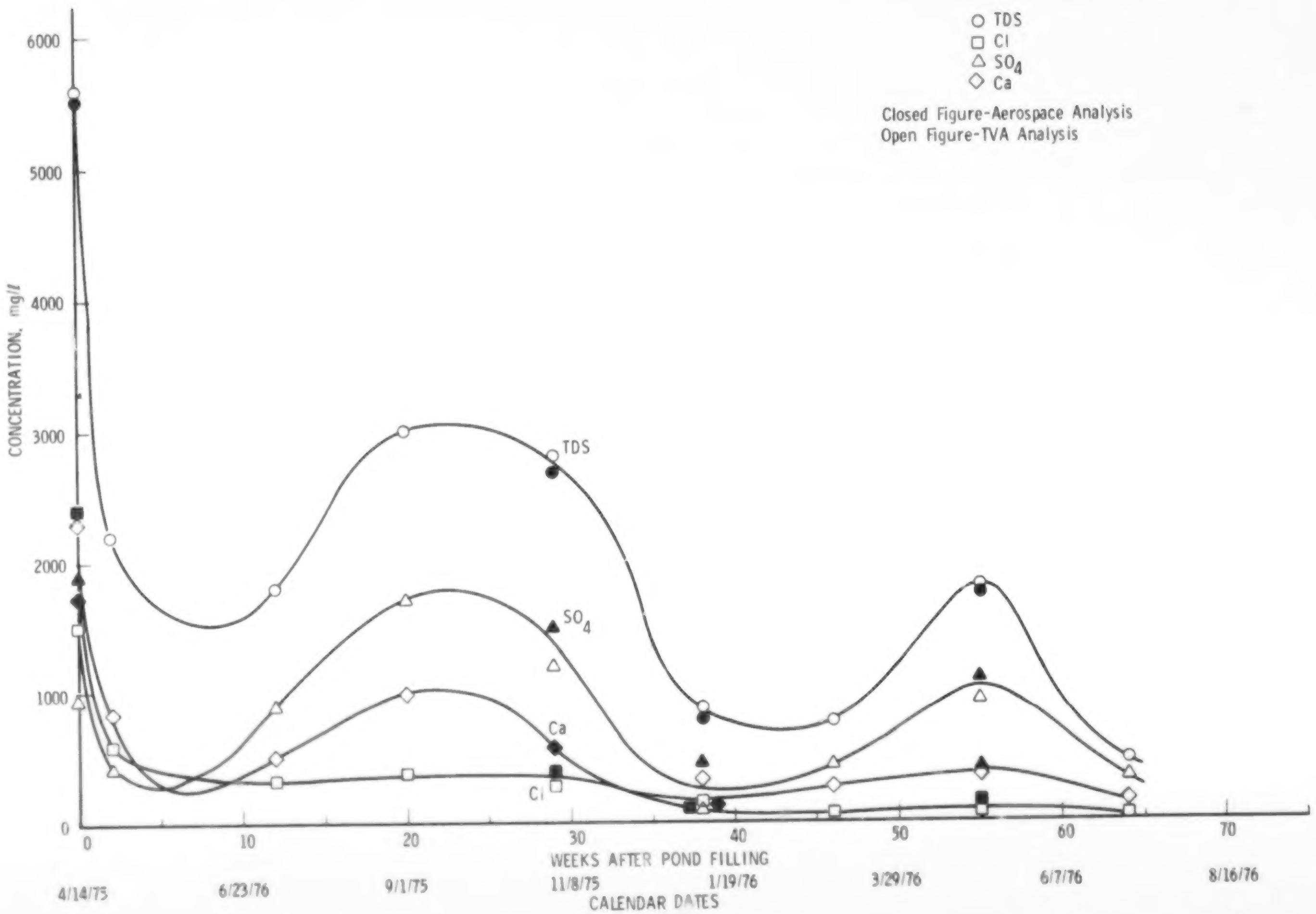


Figure 36. Concentrations of TDS and major species in Pond B supernate

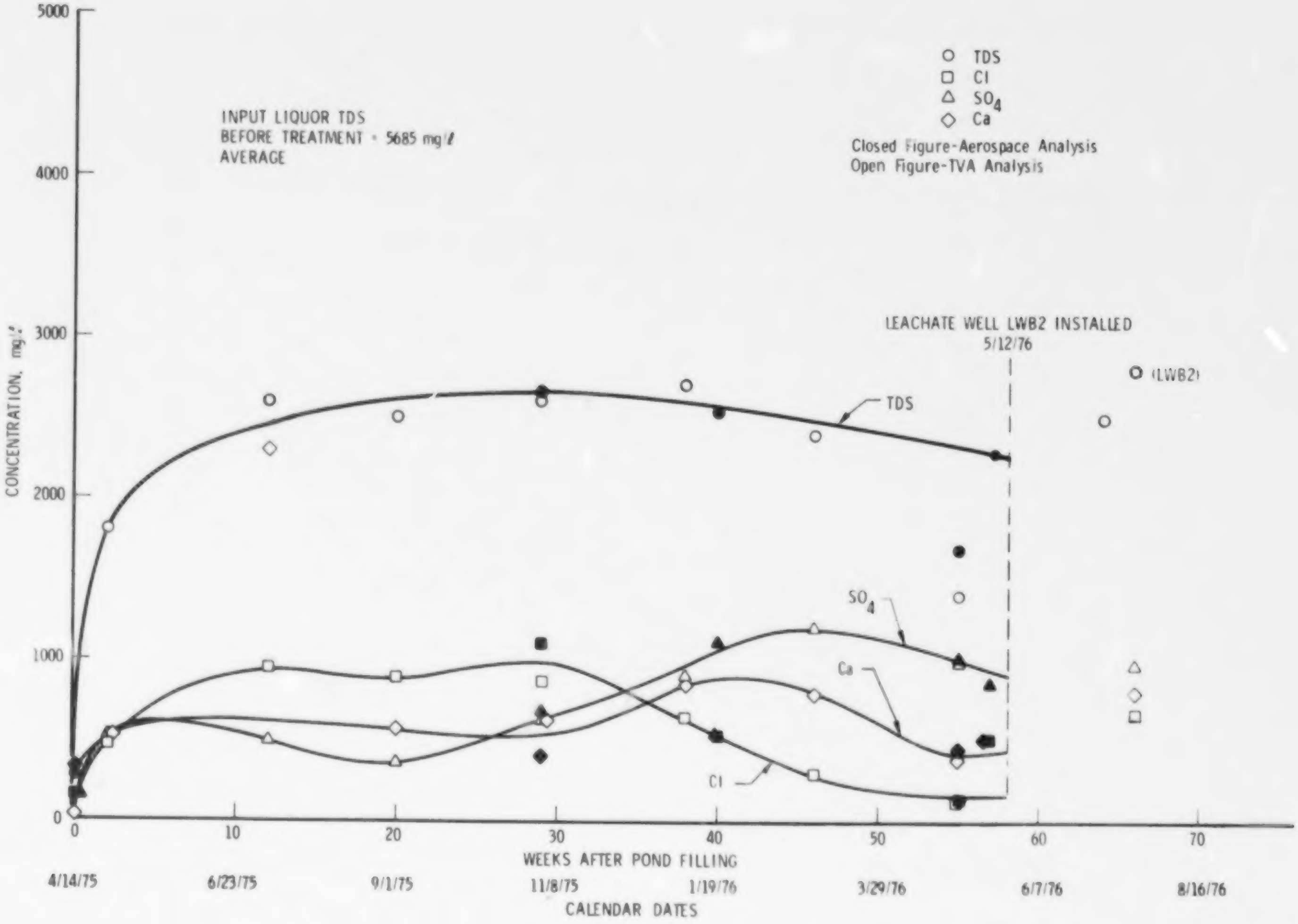


Figure 37. Concentrations of TDS and major species in Pond B leachate

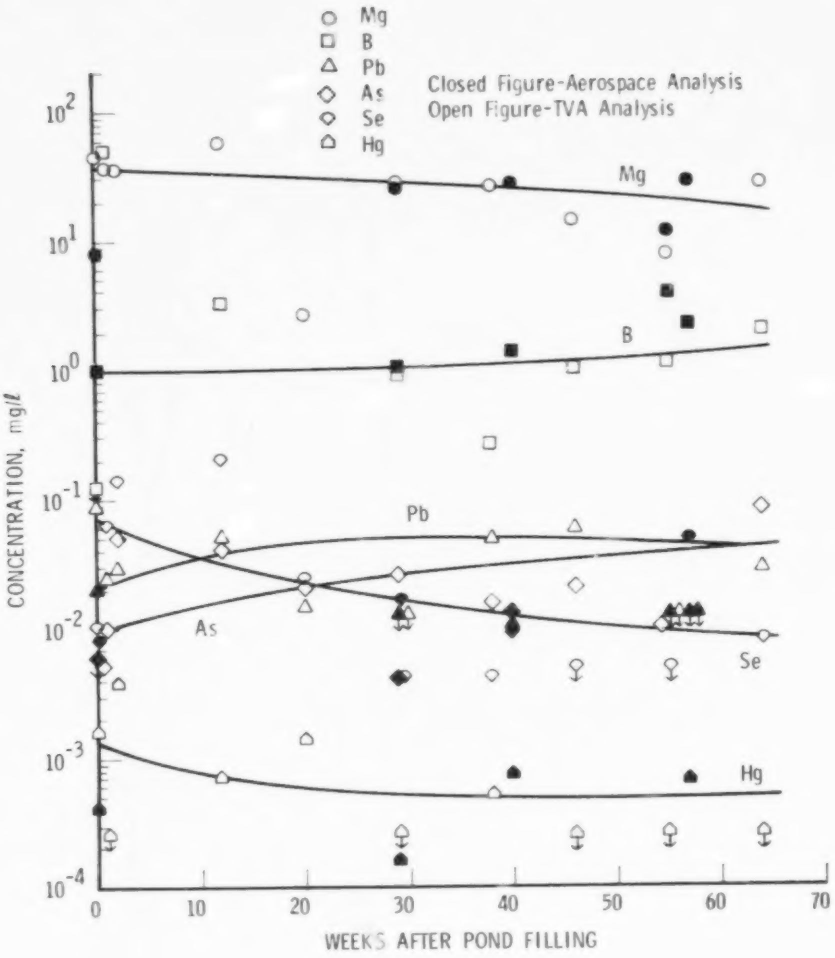


Figure 38. Concentrations of minor species in Pond B leachate

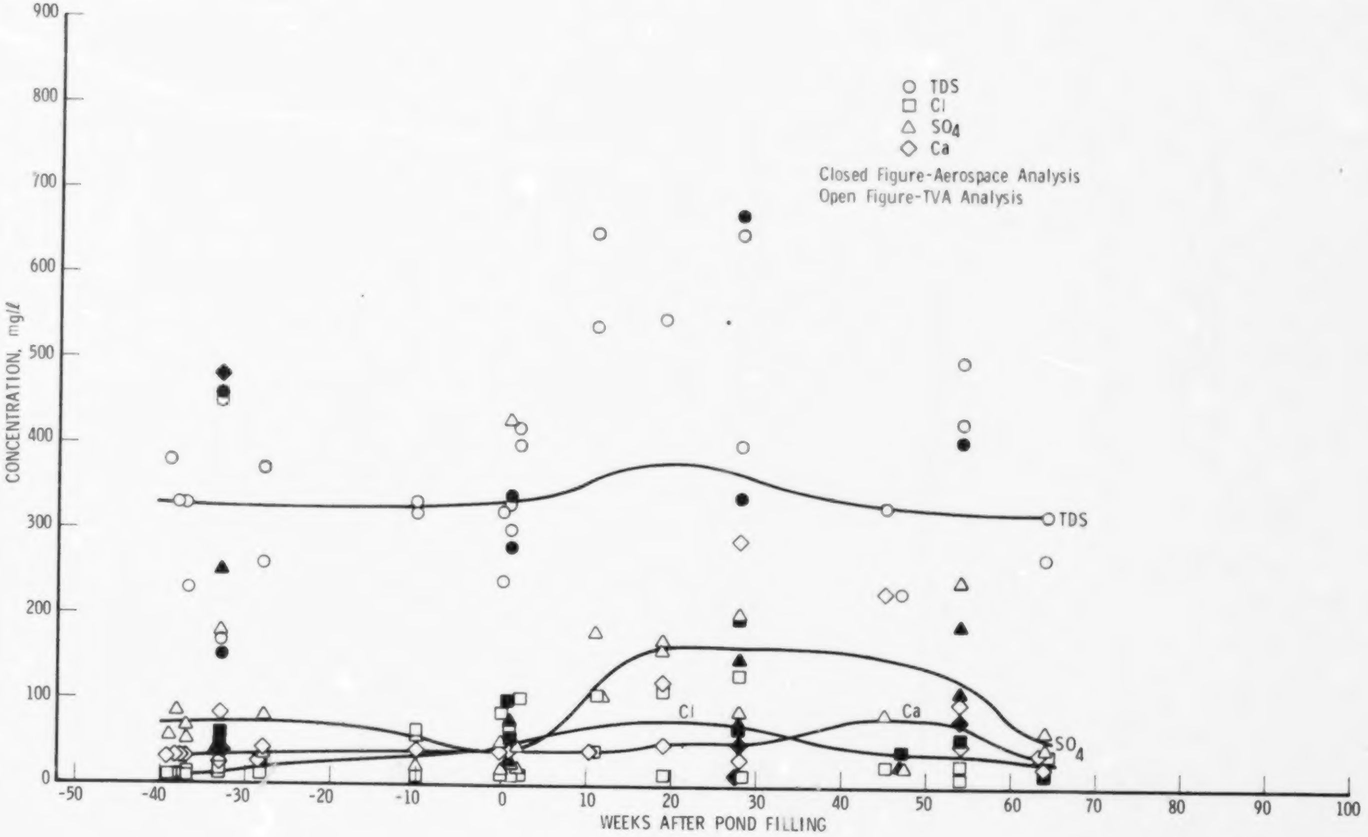


Figure 39. Concentrations of TDS and major species in Pond C groundwater

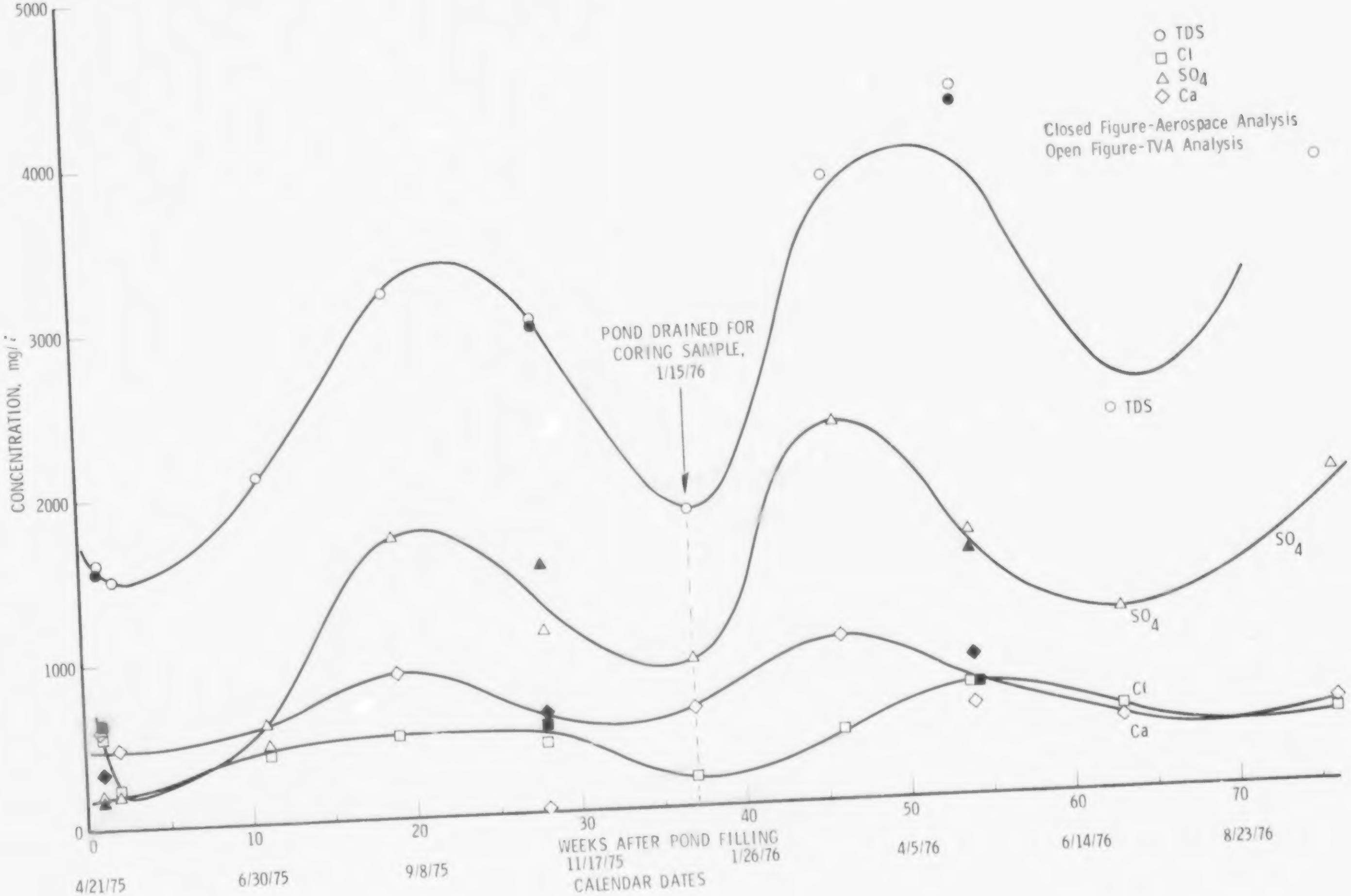


Figure 40. Concentrations of TDS and major species in Pond C supernate

covered. The minima correspond to cooler and/or more rainy periods when most of the pond surface was covered. Dilution of the supernate with rainwater caused the decreased concentration levels that were observed.

In the leachate from Pond C, the concentrations of the major species and TDS changed with time in a pattern different from those of the other ponds, as shown in Figure 41. The concentrations one week after pond filling were high, approximately one half of the corresponding values in the pond input liquor. This is believed to be the result of a dry leachate well at the time that the pond was filled. The concentration of calcium decreased rapidly to a level which remained constant to the end of the period monitored. The chloride concentration also decreased to a level which remained until early in 1976, when it decreased abruptly to a minimum, then increased slightly, and was again decreasing at the end of the period monitored. It is possible that there was a correlation between the variation of chloride concentration with time in the leachate and in the pond supernate (Figure 40). The concentration of sulfate decreased initially and then increased, first rapidly and then at a slow rate which persisted to the end of the period monitored. As expected, the TDS curve reflected a composite of the other curves. No samples were available for analysis in November 1975 because the leachate well was dry. The time-dependent variations of the concentrations of the six minor elements are shown in Figure 42. For five elements, the concentrations were relatively constant over the period monitored, but for boron there is evidence of a uniform rate of increase in concentration with time which persists to the end of the period.

8.2.3 Pond E Water Analyses

The material used in the initial filling of Pond D was chemically treated by Chemfix and transferred to Pond E in December 1974. Because of unseasonably dry conditions at that time, no leachate well data for Pond E were obtained until February 1975. One of the two groundwater wells associated with Pond E had been monitored for a period of 17 weeks prior to pond filling. A second groundwater well was also monitored beginning 10 weeks after pond filling. TDS and major constituent concentrations for these wells have been plotted in Figure 43. No trends that can be attributed to the effects of Pond E treated sludge are apparent.

For Pond E supernate, the TDS and concentrations of major constituents, including sodium, have been plotted in Figure 44. Although no data were available for the first nine weeks after pond filling, the first measured concentrations are far below the levels for the untreated input material. Subsequently, the concentrations varied with the seasons in the same manner as has been described previously. The sodium and chloride concentrations decreased with time, and the sulfate and calcium concentrations increased with time during the period monitored.

For the leachate of Pond E, the concentrations of major constituents, including sodium, and the TDS have been plotted in Figure 45, and plots of the concentrations of six minor constituents are shown in Figure 46. No data points are available for the first nine weeks after pond

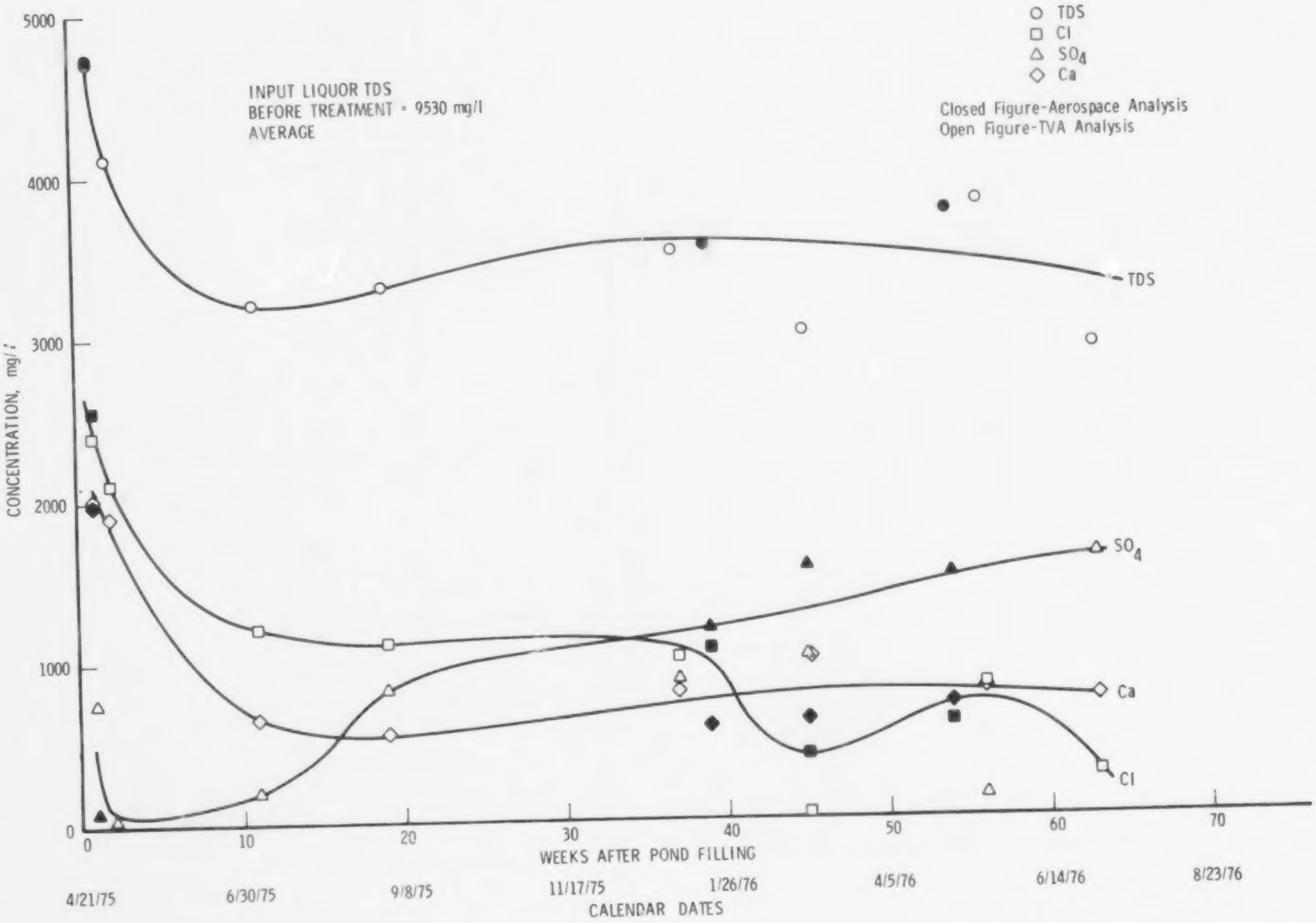


Figure 41. Concentrations of TDS and major species in Pond C leachate

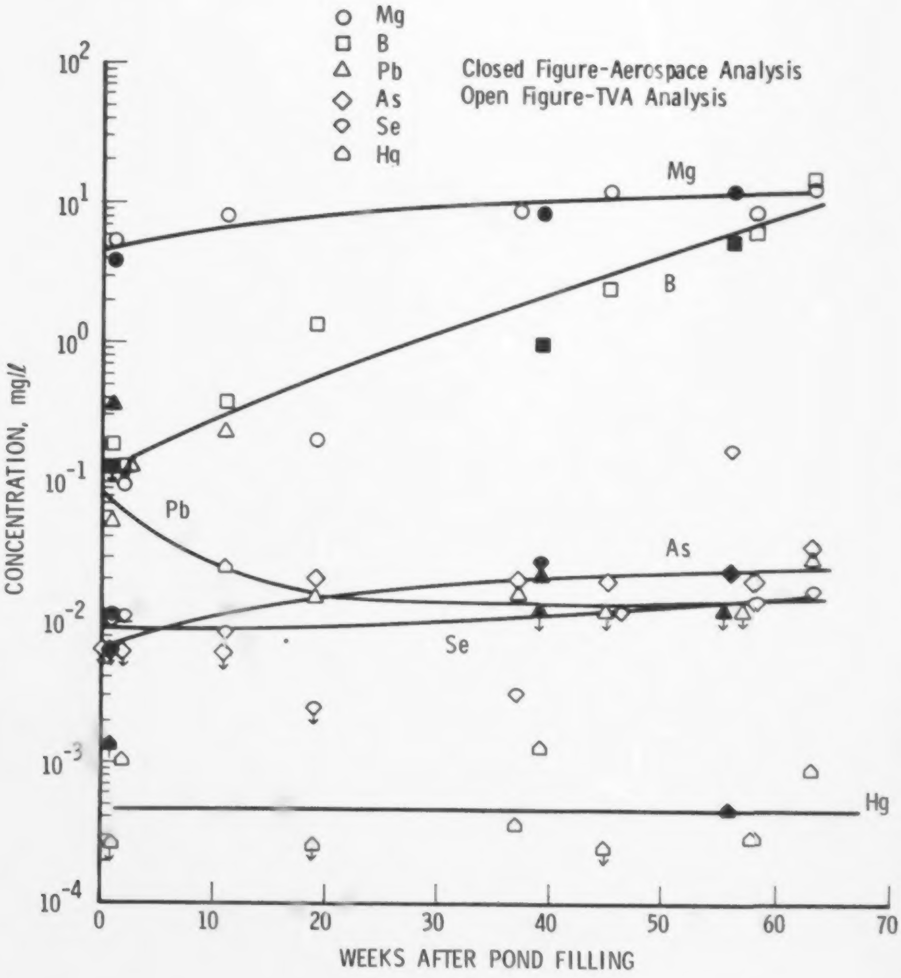


Figure 42. Concentrations of minor species in Pond C leachate

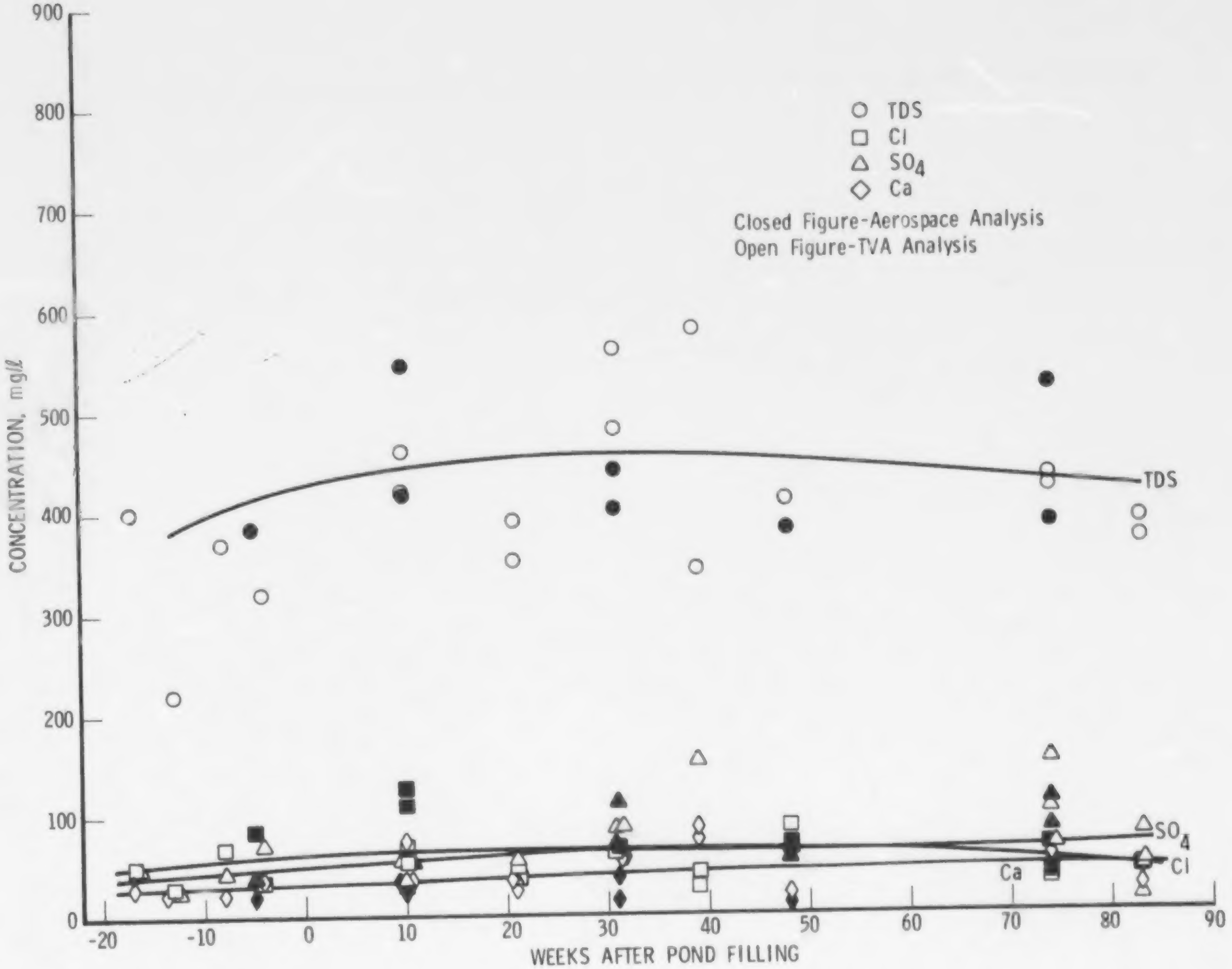


Figure 43. Concentrations of TDS and major species in Pond E groundwater

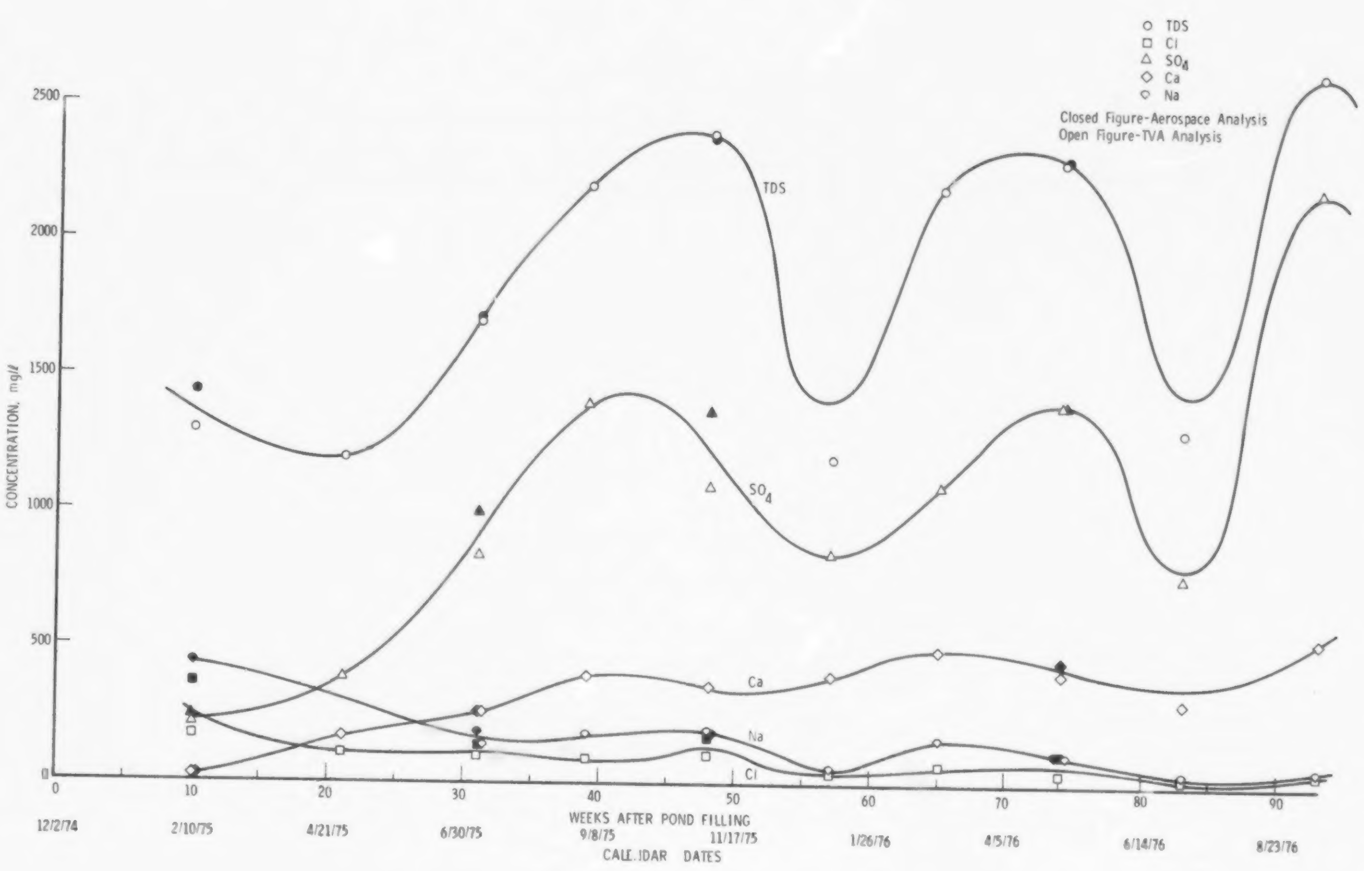


Figure 44. Concentrations of TDS and major species in Pond E supernate

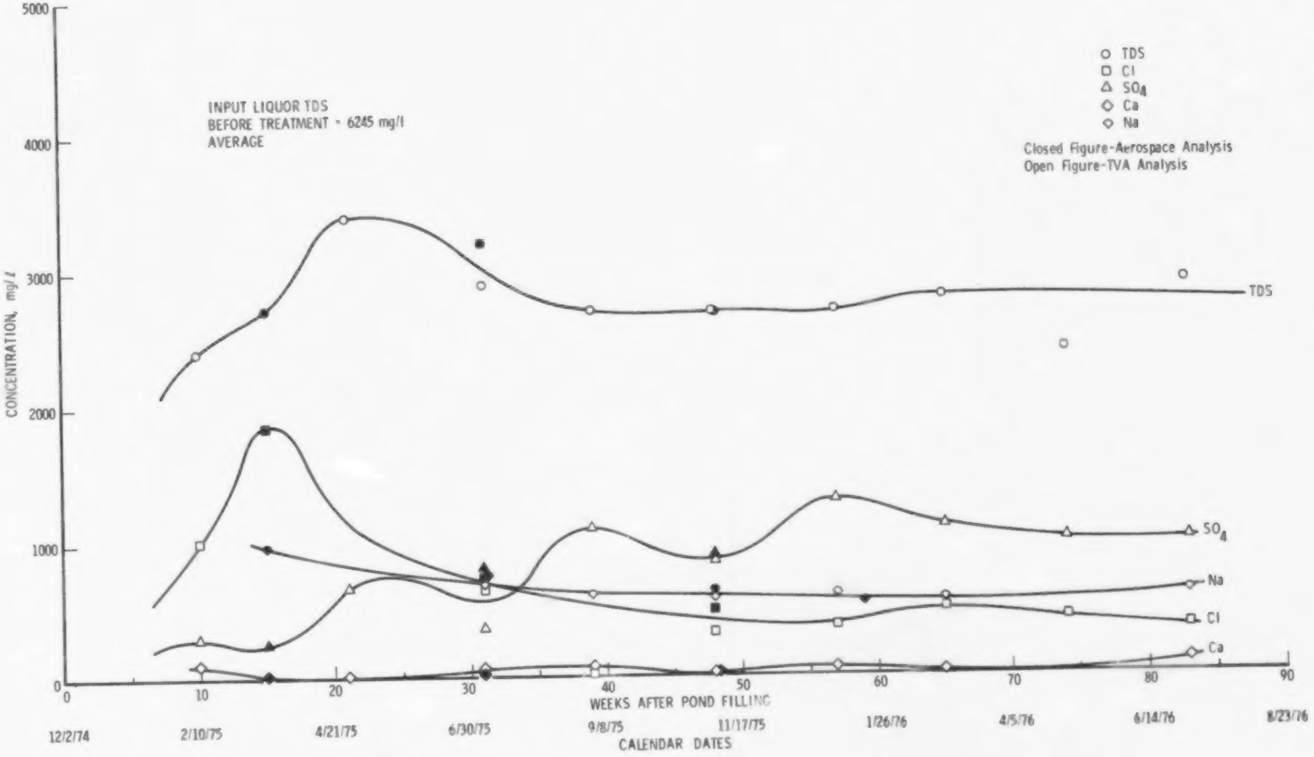


Figure 45. Concentrations of TDS and major species in Pond E leachate

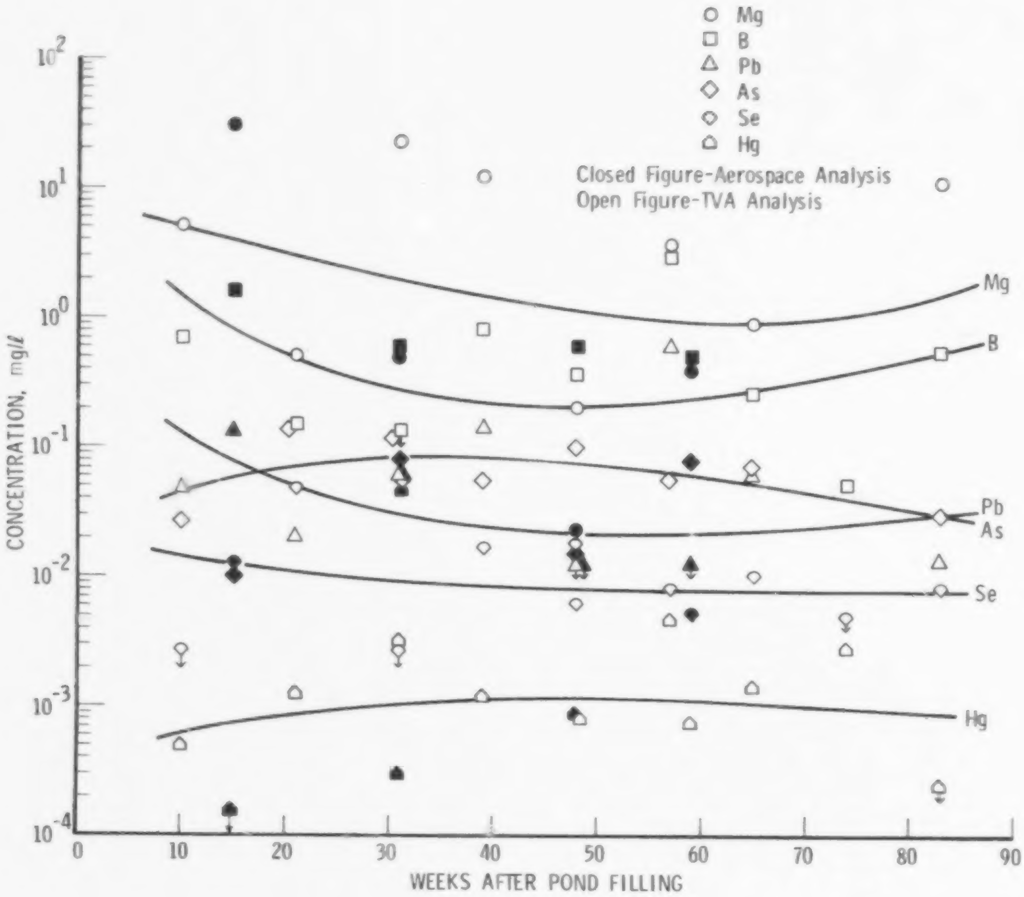


Figure 46. Concentrations of minor species in Pond E leachate

filling. The major constituents appear to have increased initially, in some cases to maximum values, and then leveled off for the remainder of the period monitored. These stationary levels ranged from a very low value for calcium to somewhat higher values for chloride and sodium. The sulfate concentration continued to increase during more than half of the monitoring period, but ultimately reached a high stationary level. The concentrations of the six minor constituents showed no significant trends during the period monitored (Figure 46).

8.3 TREATED SLUDGE CORE ANALYSES

8.3.1 Physical Characteristics

Cores were removed periodically from each of the ponds containing fixed sludge for physical and chemical characterization. Physical testing included water permeability, density, and compressive strength measurements, both in the as-received and dry conditions. The methods used in the tests are described in Appendix D. Results of measurements on cores taken through March 1977 are given in Table 14. At least one core from each pond was received in such a condition that some or all of the characterization measurements were not possible. Permeability coefficients averaged 8×10^{-5} cm/sec for Pond B, 2×10^{-5} cm/sec for Pond E, and 5.5×10^{-5} cm/sec for Pond C, but with selected crack-free samples exhibiting coefficients as low as 3.2×10^{-7} cm/sec. Average water contents for the cores from the three ponds were 38 percent for C, 49 percent for E, and 54 percent for B. The average pore volume fractions were 0.63 for Pond C, 0.7 for Pond E, and 0.75 for Pond B. Thus, the Pond C material is the most impervious of the three. The advantages of low permeability and proper site management to reduce or eliminate seepage are discussed in Section 4.5.1 and Appendix C.

Bulk densities in the as-received condition were approximately twice the corresponding dry densities for Ponds B and E, e.g., 1.4 vs 0.7 g/cm^3. For Pond C, with slightly higher bulk densities, the average value for the as-received condition was approximately 1-1/2 times as great as that of the dry material. The greatest differences were found in the compressive strengths of free-standing samples which did not appear to be sensitively dependent on the moisture contents. Cores taken from Pond C showed compressive strengths of about 30 kg/cm^2 compared to 4 and 8 kg/cm^2 for material from Ponds B and E, respectively. No measurements have been made as yet on the cores taken in July 1976.

8.3.2 Accelerated Leaching Tests

Leaching tests were conducted on cores taken from ponds containing chemically fixed sludge where the core was sufficiently intact and crack-free that meaningful data could be obtained. Deionized water was passed through the core segment, and incremental volumes of leachate were collected and analyzed for major liquor constituents and for TDS. More details on the method used for this test are contained in Appendix D. Analyses for major constituents were usually conducted on the first and

Table 14. PHYSICAL CHARACTERISTICS OF IMPOUNDED TREATED SLUDGE CORES

Pond	Coring Date	Moisture Content, wt %	Density, g/cm^3 (wet)	Unconfined Compressive Strength, kg/cm^2[a]		Density, g/cm^3 (dry)	Porosity, void fraction (volumetric)	Permeability Coefficient, cm/sec
				wet	dry			
B	5/29/75	49	1.43	4.5	2.8	0.73	0.71	--
B	6/12/75	58	1.40	2.1	3.0	0.61	0.76	6.9×10^{-5}
B	7/30/75	56	1.30	2.0	1.5	0.56	0.77	1.4×10^{-4}
B	1/14/76	54	1.37	5.9	--	0.63	0.75	3.8×10^{-5}
C	5/29/75	37	1.69	32.5	35.5	1.07	0.58	5.5×10^{-5}
C[b]	6/12/75	41	1.42	22.6	27.5	0.80	0.68	5.5×10^{-7}
C	1/14/76	39	1.50	2.8	--	0.91	0.64	3.2×10^{-7}
C	7/7/76	38	--	--	--	--	--	5.4×10^{-5}
C	3/15/77	38	1.50	1.50	--	0.93	--	5.6×10^{-5}
E	2/27/75	51	1.43	8.3	9.4	0.71	0.72	1.5×10^{-5}
E	2/27/75	--	--	--	--	--	--	2.7×10^{-5}
E	7/29/75	--	--	--	--	--	--	9.3×10^{-5}
E	1/14/76	48	1.43	1.7	--	0.74	0.70	1.2×10^{-5}
E	7/7/76	51	--	--	--	--	--	5.7×10^{-6}
E	3/15/77	47	1.30	--	--	0.69	--	1.6×10^{-6}

[a] kg/cm^2 × 14.22 = psi.

[b] Selected samples without visible cracks.

last samples of leachate. Leaching data are plotted in Figure 47 for a core taken from Pond B in June 1975. Leaching of this core was continued until more than 8 pore volumes had been eluted. Although the chloride concentration in the final leachate sample was less than 1/10 of that in the first sample, the calcium and sulfate concentrations were only moderately lower. Solubility calculations demonstrate that both leachate samples were effectively saturated with gypsum, $CaSO_4 \cdot 2H_2O$.

For the Pond C core of May 1975 (Fig. 48), leaching was continued until 27 pore volumes had been eluted. The TDS and chloride concentrations in the final eluted volume were less than 10 percent of the concentrations in the pond input liquor (see Table B-17, Appendix B). The decreases in concentrations of sulfate and calcium were only 3- to 5-fold.

Leaching tests of two samples of a Pond E core, taken in February 1975, showed TDS concentrations, after 2 pore volumes, 3 to 5-fold less than the input liquor TDS concentrations (see Table B-1, Appendix B). The difference in the TDS concentrations between the two samples (Figure 49) is presumed to be a result of a difference in the respective internal structures of the samples, e. g., coefficients of permeability vary from sample to sample by factors of two or more. Therefore, leaching rates and resultant effects vary. Calcium concentrations are very low in leachates from Pond E treated sludge, presumably because of ion exchange with sodium. Further testing in this project will be conducted in an attempt to correlate physical properties with leaching results.

8.4 SOIL CORE ANALYSES

Soil cores taken from the ponds containing untreated sludge were tested for water permeability and leaching characteristics. Cores were taken from Pond A in July 1975 and from Pond D in February 1975. Permeability coefficients for both cores are about 10^{-7} cm/sec, which is typical of lean clay. The leachate from the cores collected after 0.02 to 0.03 pore volume displacements were analyzed for the major constituents of sludge liquor. The results are shown in Table 15. The TDS content of the soil leachates are comparable to those of the pond input sludge liquors although the calcium and sulfate concentrations are considerably lower. The high sodium concentrations in the leachates, particularly from Pond A, give evidence of cation exchange occurring in the soil. A measurement of the ion-exchange capacity of soil taken from the bottom of Pond A prior to filling gave a value of 0.46 milliequivalents/100 g of soil.

Additional soil cores were removed and tested by TVA when groundwater wells GWG2 and GWH2 associated with the new ponds were constructed in May 1976. TVA has reported the test data shown in Table 16. The lean clay soil that forms the bottoms of the ponds has a dry density of 1.6 to 1.8 g/cm^3, a permeability of 10^{-6} to 10^{-8} cm/sec, and a natural moisture content of 13 to 21 weight percent.

Soil tests, using an ion microprobe mass analyzer (IMMA), to investigate the permeation of major constituents was reported on in the

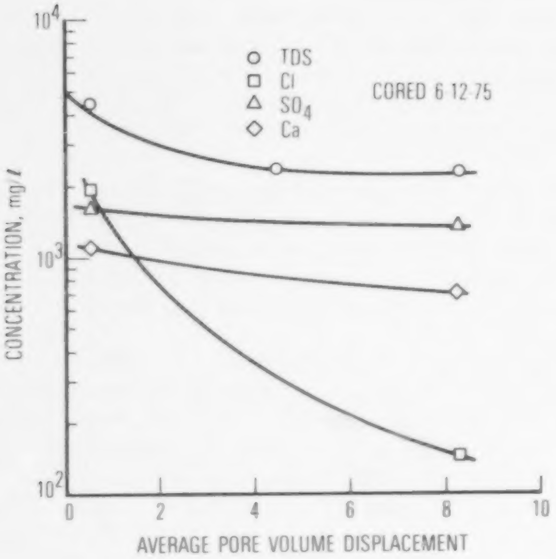


Figure 47. Concentrations of TDS and major species in Pond B sludge core leachate

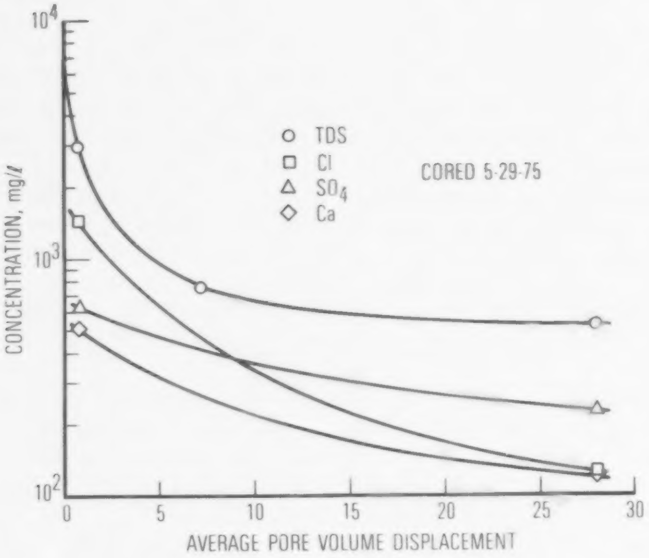


Figure 48. Concentrations of TDS and major species in Pond C sludge core leachate

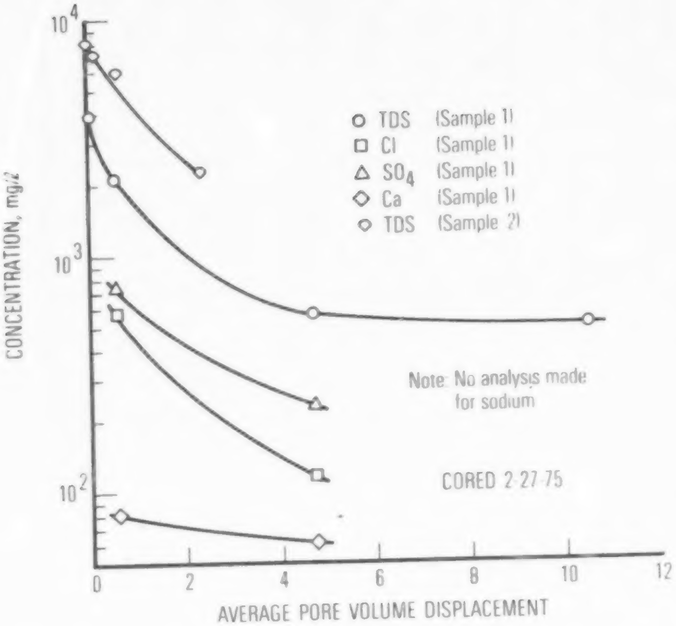


Figure 49. Concentrations of TDS and major species in Pond E sludge core leachate

TABLE 15. POND SOIL PERMEABILITY AND LEACHING CHARACTERISTICS[a]

Pond	Coring Date	Soil Permeability Coefficient, cm/sec	Average Pore Volume Displacement	Leachate, mg/ℓ				
				TDS	Cl	SO_4	Ca	Na
A	7/29/75	2.8×10^{-7}	0.015	--	2600	550	800	3300
D	2/27/75	1.1×10^{-7}	0.028	5850	1850	450	400	560

[a] Samples taken from ponds containing untreated sludge.

TABLE 16. RESULTS OF LABORATORY TESTING OF SHAWNEE SOIL BY TVA

Depth Below Grade, ft	Soil Symbol[a]	Natural Moisture Content, %	Grain Size Analysis, %				Atterberg Limits, %		Dry Density, g/cm^3	Permeability Coefficient, cm/sec
			Gravel	Sand	Silt	Clay	Liquid Limit	Plasticity Index		
Groundwater Well GWG2										
8.0 - 9.9	CL	21.5	--	4	73	23	33.4	14.7	1.61	5.7×10^{-7}
19.0 - 20.7	CL	16.9	--	15	60	25	33.0	18.9	1.79	5.1×10^{-8}
25.0 - 25.6	ML	12.6	--	24	53	23	18.7	2.7	1.83	5.8×10^{-7}
29.0 - 30.0	SC	13.1	11	49	26	14	24.4	13.6	1.91	2.1×10^{-6}
Groundwater Well GWH2										
8.0 - 9.5	CL	18.0	--	3	77	20	31.7	12.4	1.72	5.7×10^{-7}
17.0 - 18.4	CL	15.3	--	8	69	23	31.8	15.3	1.68	3.5×10^{-6}
26.1 - 27.4	ML	17.2	--	20	69	11	20.6	3.0	1.81	1.0×10^{-6}

[a] Soil Symbols:

CL = lean clay
ML = clayey fine sand
SC = clayey sand

initial report on this project (Ref. 1). This analytical approach was discontinued because of the heterogeneity of the soil samples and the tendency of the sample surface to become charged by the ion beam, thereby increasing the difficulty of obtaining representative and reproducible analyses. Alternative analytical techniques are being investigated, and the results will be reported in the next annual report.

A sample of Celatom (diatomaceous earth) which was received from TVA Shawnee was tested to determine whether it was sufficiently chemically inert to justify its use as a solids filtration medium in the new leachate wells of the Shawnee sludge disposal ponds. The results of two tests are shown in Table 17. In the leaching test, deionized water was passed through a column containing a bed of Celatom until more than 3 (estimated) pore volumes had been displaced. Analyses of the first and last incremental volumes are shown in the table. The initial sample contained principally dissolved sodium chloride and sodium sulfate. Although the TDS content is comparable to or lower than that of the groundwater at Shawnee, the pH is somewhat higher. After elution of 3 pore volumes of water, the bed had been washed essentially free of soluble substances. After the leaching test was completed and the bed had drained, an attenuation test was conducted by passing sludge liquor through the same bed until more than 4 pore volumes had been displaced. Analyses of incremental eluted volumes and the comparative values for the input liquor given in Table 17 showed that approximately one pore volume of liquor was required to displace the residual water in the bed from the prior test. Subsequent eluted samples showed the same composition as that of the input sludge liquor. These data demonstrate that the Celatom did not attenuate the sludge liquor components and was not leached significantly by pure water. It is therefore acceptable for solids filtration purposes.

8.5 CLIMATOLOGICAL AND HYDROLOGICAL DATA

Daily measurements of rainfall, evaporation, wind, and temperature have been taken at the pond site. Only the cumulative weekly rainfall and net moisture accumulation* data are being reported here. These data are plotted in Figure 50 for the period from April 1975 to September 1976. The evaporation pan was out of service during early 1975, and during the winter months of 1976 was not used because of ice formation. Therefore, it was not possible to estimate the cumulative gain in moisture for the entire period. For the period that evaporation

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* The net moisture accumulation is calculated as the difference between the gain due to precipitation and 7/10 of the evaporation loss as measured with the Hook gauge evaporation pan.

TABLE 17. LEACHING AND ATTENUATION TESTS OF CELATOM, DIATOMACEOUS EARTH

Average PVD	pH	Concentration, mg/ℓ					
		TDS	Ca	SO_4	Cl	Mg	Na
Leachate Test, Using Deionized Water							
0.3	10.07	272	0.8	46	70	0.06	97
0.9	--	80	--	--	--	--	--
1.5	--	34	--	--	--	--	--
2.0	--	20	--	--	--	--	--
3.2	8.71	10	0.2	<5	2	<0.01	5
Attenuation Test, Using Sludge Liquor							
0.4	5.89	--	140	650	165	81	395
1.1	3.07	--	550	3000	2300	335	1445
1.7	2.59	--	500	3250	2700	328	1485
2.3	2.53	--	500	3250	2300	375	1560
3.7	2.48	--	550	3500	--	375	1595
Input Liquor	2.45	--	550	3750	2500	375	1550

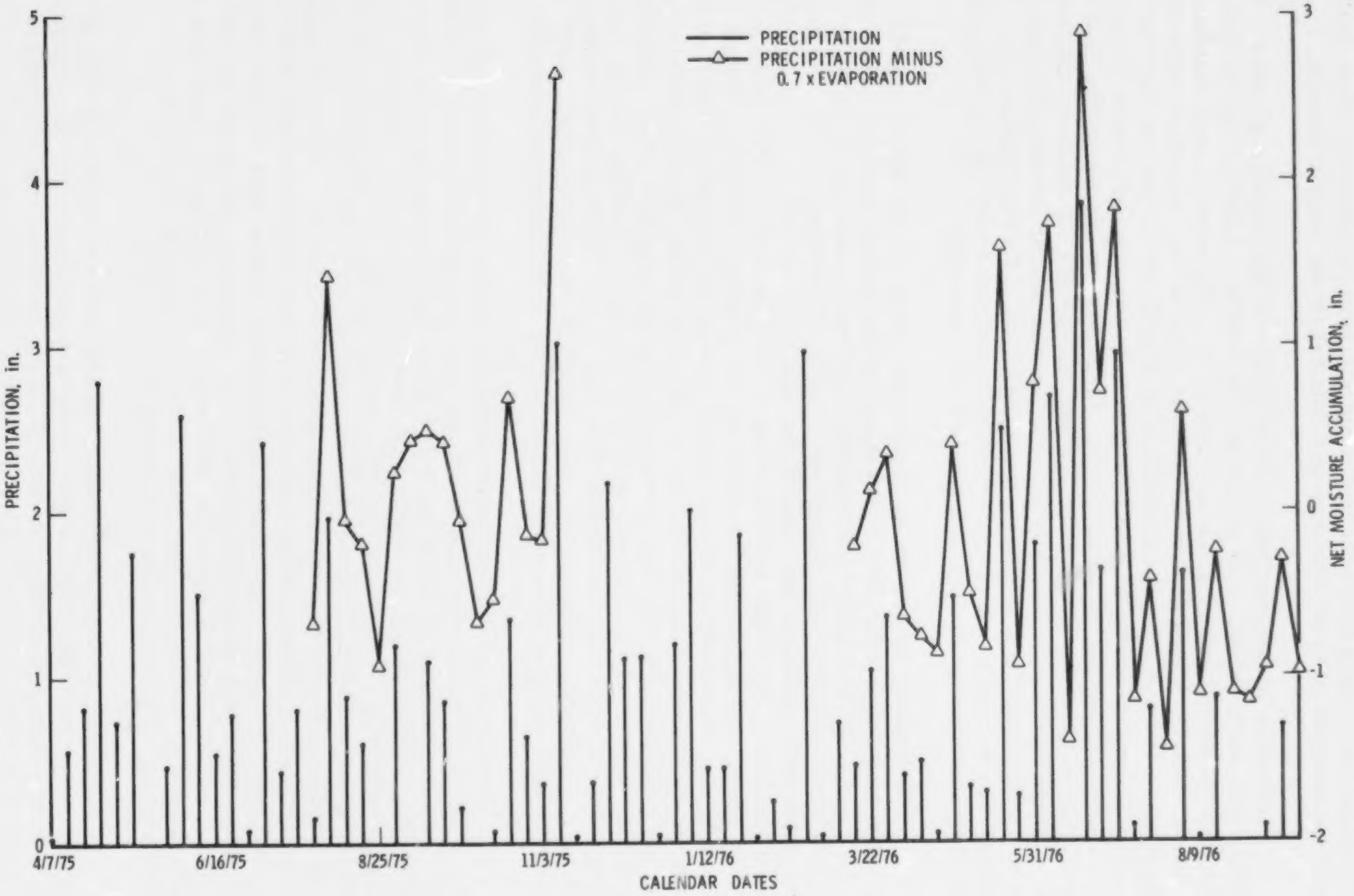

Figure 50. Shawnee weekly precipitation and net accumulation of moisture

was monitored, the net moisture accumulation amounted to less than 2 inches. Although the precipitation is fairly well distributed over the period monitored, the net moisture accumulation is less so, thus causing seasonal variations in both surface and underground water levels.

Weekly measurements were made of the depths of water in the ponds, leachate wells, and groundwater wells. Monitoring of the leachate well water levels began in June 1975. Supernate and leachate well data for Ponds A and D are plotted in Figure 51, together with weekly precipitation. Pond A was discontinued in April 1976, and no further measurements were made at this location. It is apparent from Figure 51 that there is a synchronous correlation of the water levels in the leachate wells with the supernate levels for both of the ponds containing untreated sludge. There were also weekly fluctuations in water levels that can be associated with high or low weekly precipitation. Precipitation was chosen for plotting rather than net moisture accumulation since the monitoring of rainfall was continuous during the period represented.

The water levels in the leachate wells of the three ponds containing treated sludge are plotted together with weekly precipitation data in Figure 52. A direct link between the supernate and the Pond B leachate well is evidenced by the well water level after November 1975. A new leachate well was installed in Pond B in May 1976 which eliminated this problem (Section 7. 3). The correlation of the leachate levels with weekly rainfall is generally apparent for each of the ponds. During periods of low rainfall, the fluctuations in the water levels of leachate wells were accentuated by the pumping of the wells which follows the bimonthly water sampling. Additionally, during periods of heavy rainfall, the supernate was partially removed in Ponds C and E to prevent flooding of the leachate pipe area, and at other times supernate was removed to allow coring operations to proceed. Therefore, the rainfall versus leachate well water level data cannot suffice for exact correlations with supernate levels.

The depth of the bottoms of the leachate wells was also monitored on a weekly basis over the same period of approximately 70 weeks. The standard deviations of the measurements were less than one inch for all five wells. Therefore, no silting or fouling of the well bottoms is indicated. In Figures 53 through 57, the water levels in the nine groundwater wells associated with the five ponds are plotted, together with weekly measurements of the level of the Ohio River at Shawnee. In most cases, the week-to-week fluctuations in water levels can be correlated with the weekly rainfall. Several apparently anomalous points may be the result of occasional spurious measurements. The seasonal variation in the water levels of the Pond A groundwater wells was different from that of the other groundwater wells, as has been observed previously (Ref. 1). Monitoring of the Pond A wells ceased in April 1976.

Although the measurements of the bottom depths of the groundwater wells span considerably larger ranges than those for the leachate wells (average standard deviation of 1. 4 feet), no systematic changes that would indicate progressive silting of the wells were observed.

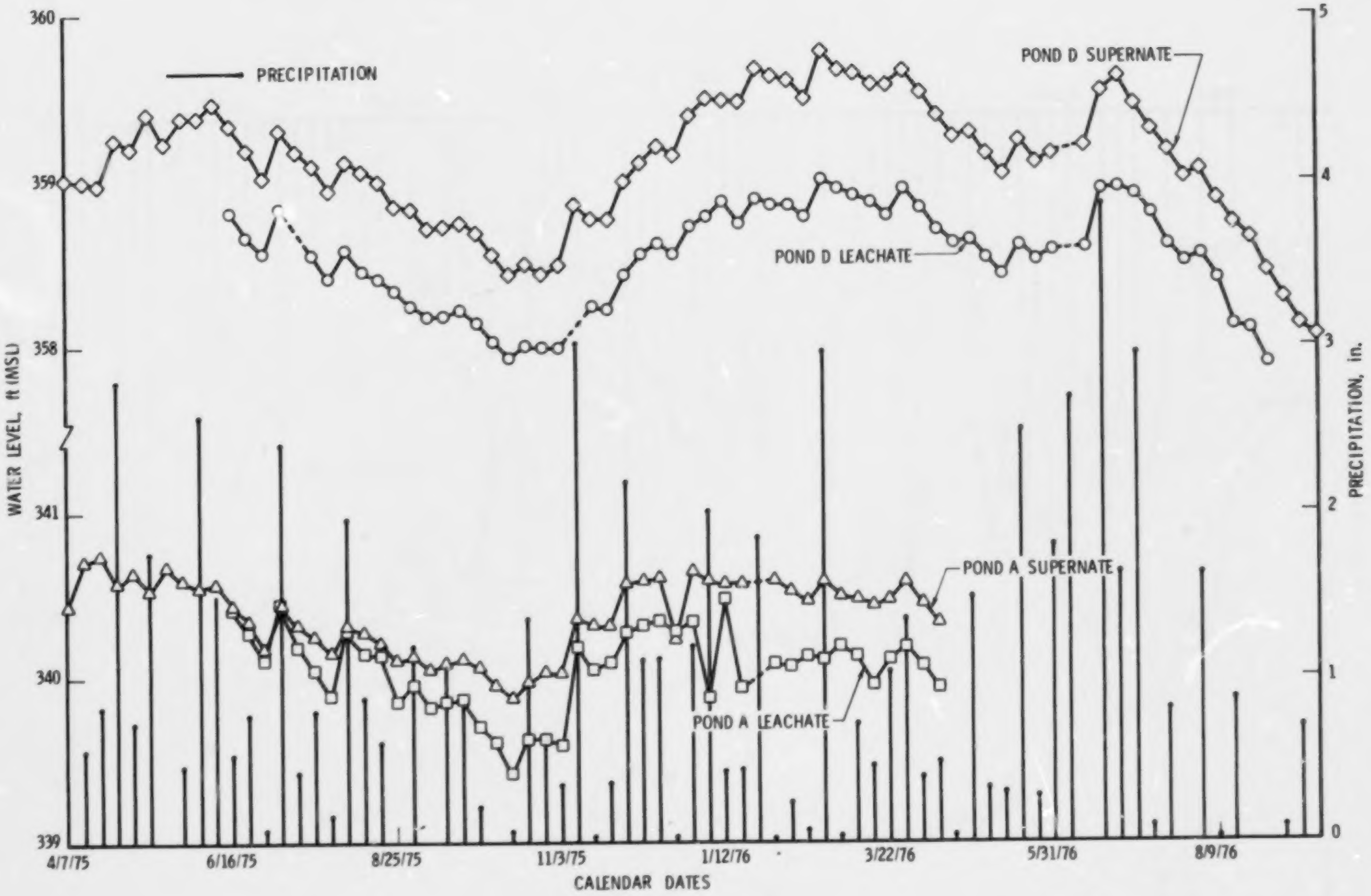

Figure 51. Shawnee weekly precipitation and water levels of Ponds A and D supernate and leachate wells

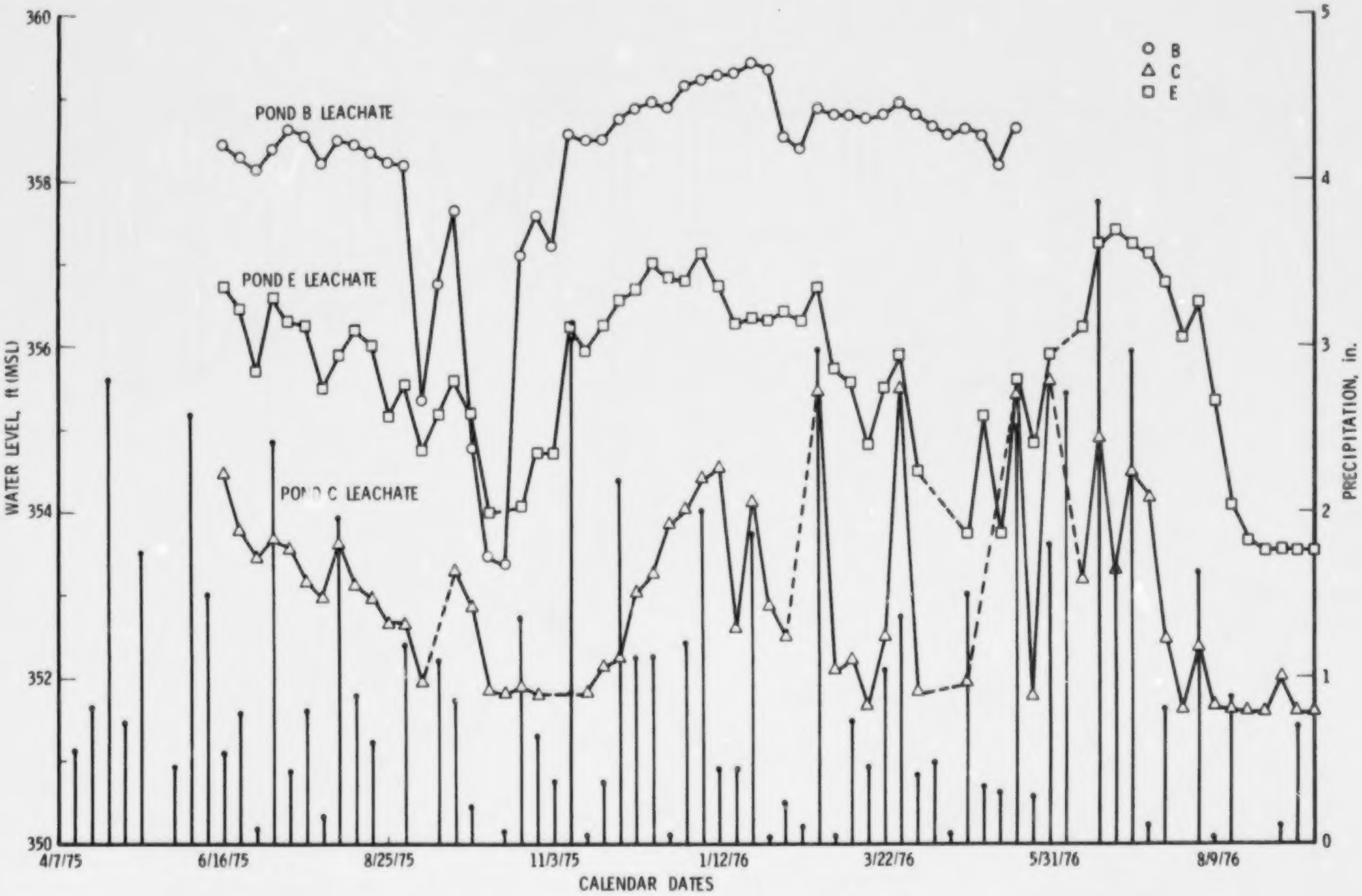

Figure 52. Shawnee weekly precipitation and water levels of Ponds B, C, and E leachate wells

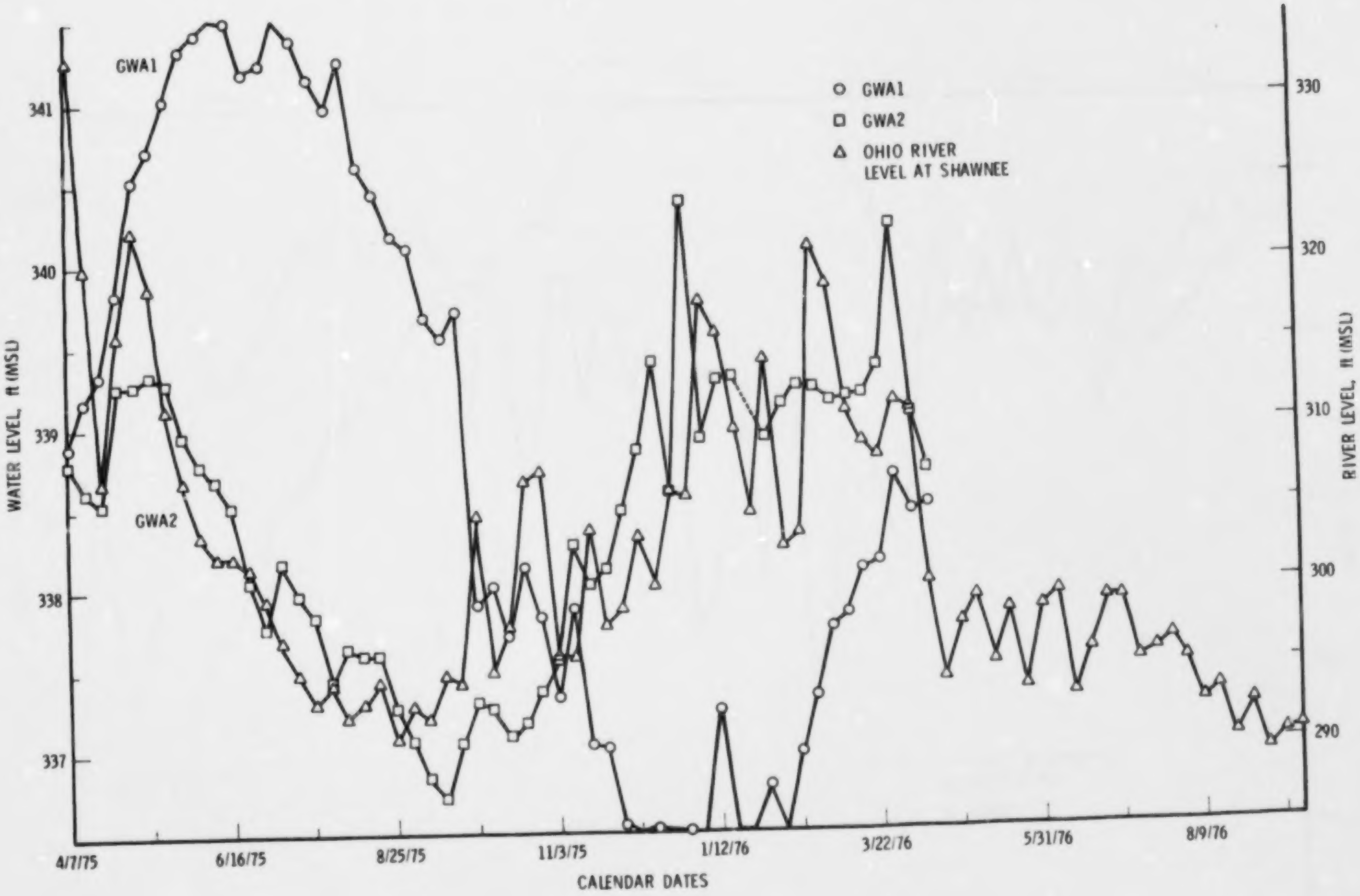

Figure 53. Shawnee weekly river stages and water levels in Pond A groundwater wells

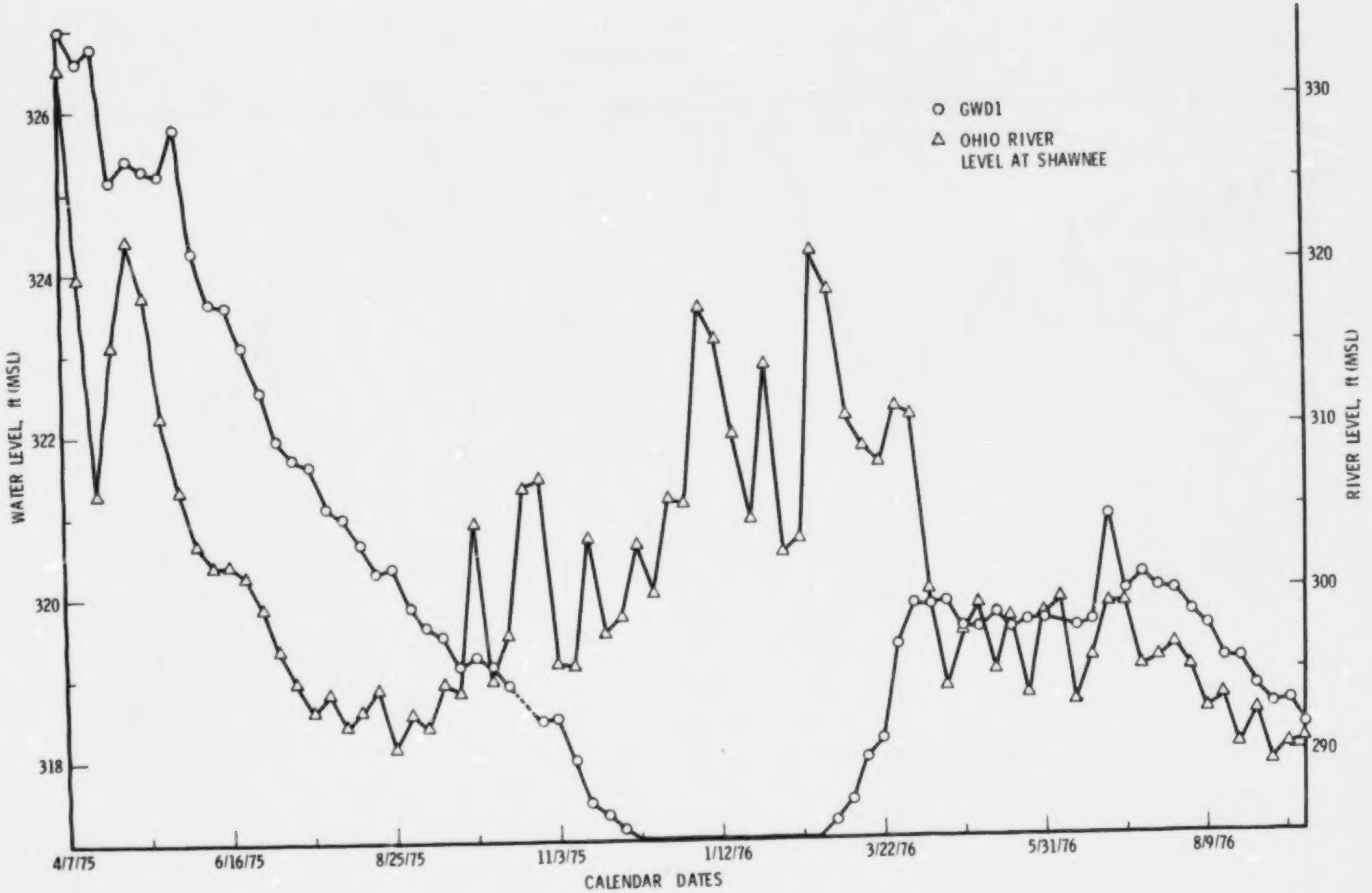

Figure 54. Shawnee weekly river stages and water levels in Pond D groundwater wells

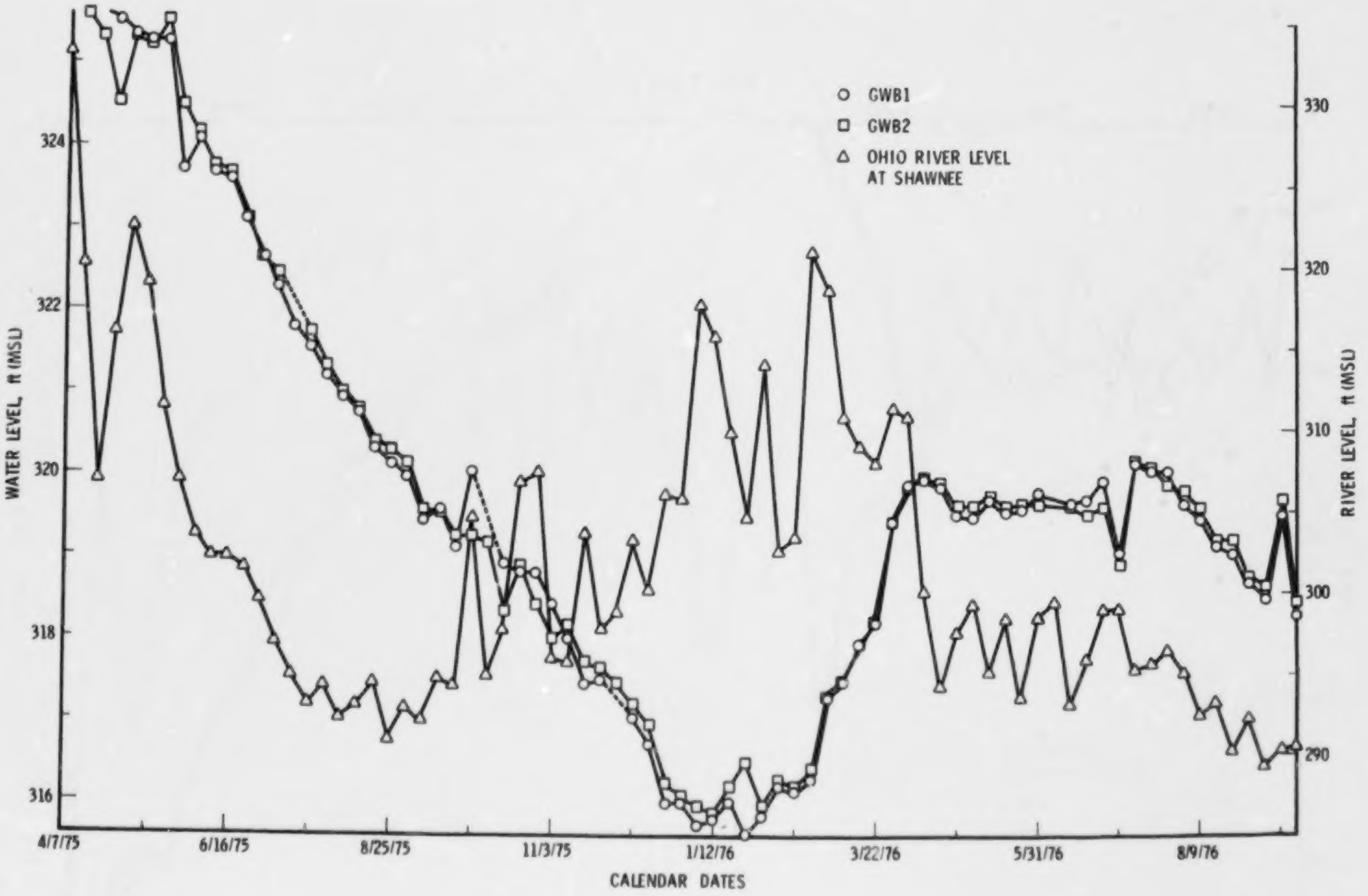

Figure 55. Shawnee weekly river stages and water levels in Pond B grounwater wells

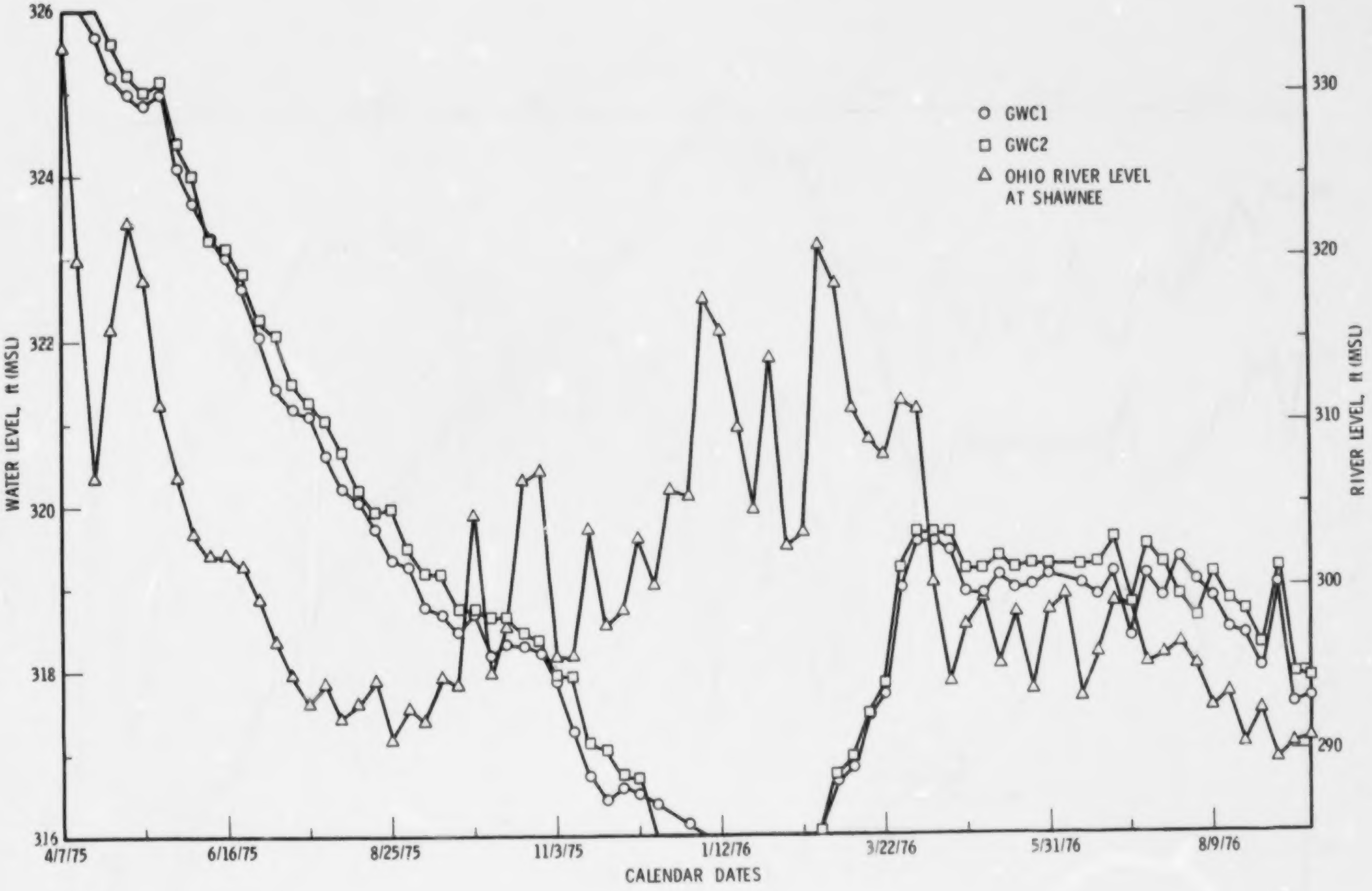

Figure 56. Shawnee weekly river stages and water levels in Pond C groundwater wells

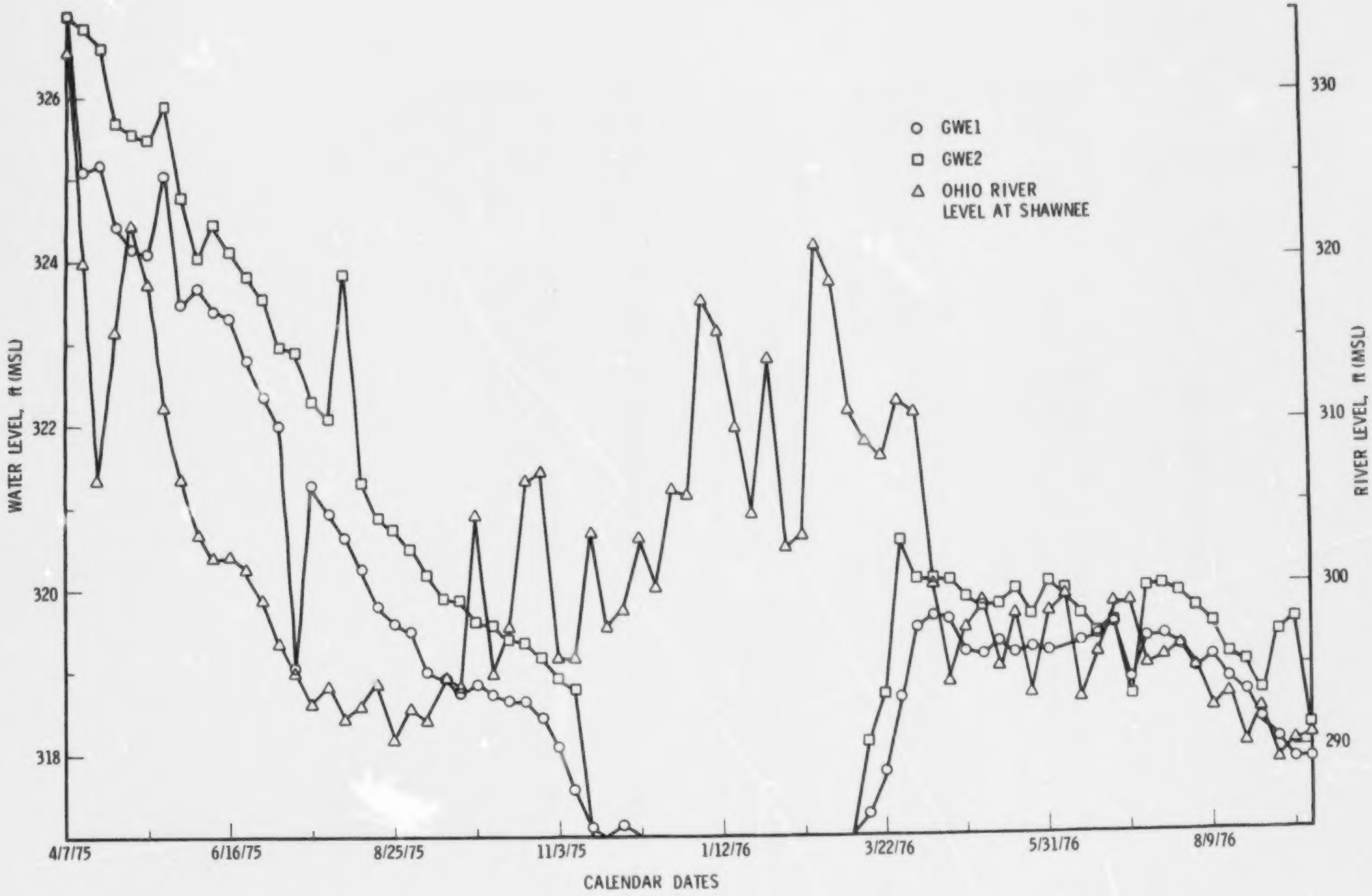

Figure 57. Shawnee weekly river stages and water levels in Pond E grounwater wells

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APPENDIX A

MATERIAL BALANCE, IONIC CHARGE BALANCE, AND GYPSUM SOLUBILITY IN POND SUPERNATES AND LEACHATES

For determination of whether analyses were complete and internally consistent, calculations were made of material and charge balances. Material balance was obtained by comparison of the sum of the ion concentrations of major species with the concentration of total dissolved solids (TDS). A deficiency of the former relative to the latter may be indicative of the presence of soluble species for which analyses have not been conducted. However, because of limitations in the accuracy of analyses, discrepancies may exist between the results of these measurements for individual samples. Examination of the results of measurements for a number of similar samples is often necessary to determine whether true deficits exist. If the sum of the ion concentrations is significantly greater than the TDS, analytical error is almost certain.

An independent test was obtained by comparison of the sum of the (equivalent) concentrations of positive ions (cations) with the sum of the (equivalent) concentration of negative ions (anions). Imbalances of ionic charge alone do not unequivocally indicate where the analytical results are in error. In conjunction with TDS data, the charge balance data are much more useful. The signs of the imbalances help to pinpoint the discrepancy. For example, if there is a TDS surplus and excess of negative ionic charge there must be a deficit amont the cation analyses. Similarly, with a TDS deficit and an excess of positive ionic charge, one or more of the cation analyses must be too high. If the ionic charge is in balance and there is a material imbalance, the TDS measurement is probably in error.

Material balances and charge balances were computed from analysis of more than 100 samples of pond supernate and leachate; the results are shown in Tables A-1 through A-5. All of the results for Pond A samples have been included; for each of the other ponds, Ponds B, C, D, and E, from two to five samples were excluded from the available data because analyses had not been made for one or more components. The results have been grouped according to date of sampling. Average charge and mass imbalances were calculated for each pond. For each of the ponds, the average mass imbalance was positive ranging from a low of

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TABLE A-1. GYPSUM SOLUBILITY RATIO, CHARGE BALANCE, AND MASS BALANCE OF POND A LEACHATE AND SUPERNATE

	mg ℓ^{-1}			meq ℓ^{-1}	mg ℓ^{-1}		meq ℓ^{-1}	Charge Imbalance (%)	mg ℓ^{-1}		Mass Imbalance (%)	moles ℓ^{-1} Ionic Strength	Solubility Ratio
Sample	Ca	Na	Mg	Σ Cation	SO_4	Cl	Σ Anion		TDS	Σ Ions			
07066LWA1	850	140	130	59.4	1100	1200	56.7	- 4.8	4100	3420	19.9	0.096	0.90
04156LWA	1000	50	53	56.6	1200	1500	67.2	15.8	4340	3800	14.2	0.102	1.05
03016LWA	1500	64	82	84.6	1200	1800	75.7	-11.8	5400	4645	16.3	0.134	1.17
01216LWA	1400	70	90	80.5	1300	2300	91.9	12.4	5860	5160	13.6	0.139	1.14
01066LWA	2500	71	74	134.3	1000	2200	82.8	-62.2	6000	5845	2.7	0.185	1.13
11035LWA	2700	120	81	147.0	940	3000	104.1	-41.2	7600	6840	11.1	0.206	1.02
11035LWA	2080	125	129	120.1	1250	3400	121.8	1.4	7560	6985	8.2	0.191	1.13
09015LWA	3000	96	120	164.2	1300	3300	120.0	-36.8	7800	7815	- 0.2	0.236	1.32
07075LWA	2300	90	82	125.7	980	3500	119.0	- 5.6	8100	6950	16.5	0.193	0.97
04285LWA	1600	---	72	86.0	1000	3300	113.8	24.4	7700	5970	28.9	0.153	0.90
04285LWA	2040	---	15	103.3	1425	2100	88.8	-16.2	7290	5580	30.6	0.162	1.53
02115LWA	2100	---	98	113.2	1100	2900	104.6	- 8.2	6600	6200	6.5	0.177	1.10
12094LWA	1200	---	120	70.0	790	1800	67.2	- 4.2	5400	3910	38.1	0.112	0.75
10154LWA	560	---	47	31.9	500	590	27.0	-18.1	2200	1695	29.6	0.051	0.61
10144LWA	460	---	49	27.1	700	840	38.2	29.2	2460	2050	20.1	0.053	0.52
07066PSA1	240	9	12	13.4	320	42	7.8	-71.8	1800	625	188	0.021	----
04156PSA	455	13	18	25.0	750	350	25.5	1.9	2080	1590	30.7	0.045	0.62
03016PSA	540	15	17	29.1	690	130	18.0	-61.7	1500	1395	7.5	0.045	0.68
01066PSA	670	20	19	36.0	540	300	19.7	-82.7	1900	1550	22.6	0.051	0.60
11075PSA	1200	27	34	64.0	1300	330	36.4	-75.8	3500	2890	21.1	0.095	1.46
11035PSA	760	30	33	42.1	1675	710	54.9	23.4	3870	3210	20.6	0.086	1.32
09015PSA	1200	23	26	63.2	1900	440	52.0	-21.5	3600	3590	0.3	0.108	1.44
07075PSA	640	16	21	34.5	810	300	25.3	-36.4	2300	1785	28.6	0.055	0.81
04235PSA	480	---	20	25.7	570	250	18.9	-35.7	1600	1320	21.2	0.041	0.54
04285PSA	540	---	5	27.4	650	390	24.5	-11.8	1540	1585	- 2.8	0.047	0.62
02115PSA	880	---	48	48.0	1100	630	40.7	-18.0	2800	2560	5.3	0.080	1.07
12094PSA	1100	---	71	60.9	1100	980	50.5	-20.6	4300	3250	32.3	0.098	1.10
10284PSA	1480	---	1	74.0	1500	1600	76.3	3.0	5850	4580	27.7	0.128	1.53
10224PSA	2000	---	140	111.7	1400	2000	85.5	-30.6	7100	5540	28.2	0.170	1.40

Average Charge Imbalance:	-17.6% (±29.1)
Average Mass Imbalance:	17.8% (±11.3)
Average Solubility Ratio:	1.02 (±0.32)

TABLE A-2. GYPSUM SOLUBILITY RATIO, CHARGE BALANCE, AND MASS BALANCE FOR POND D LEACHATE AND SUPERNATE

	mg ℓ^{-1}			meq ℓ^{-1}	mg ℓ^{-1}		meq ℓ^{-1}	Charge Imbalance	mg ℓ^{-1}		Mass Imbalance	moles ℓ^{-1}	
Sample	Ca	Na	Mg	Σ Cation	SO4	Cl	Σ Anion	(%)	TDS	Σ Ions	(%)	Ionic Strength	Solubility Ratio
07066LWD	640	22	29	35.4	1500	190	36.6	3.3	3000	2380	26.1	0.069	1.22
05036LWD	470	17	14	25.4	1200	180	30.1	15.6	2600	1880	38.3	0.053	0.92
05036LWD	600	17	18	32.2	1400	240	35.9	10.4	2560	2275	12.5	0.065	1.13
03016LWD	1000	11	18	52.0	1100	----	----	----	2600	2185	19.0	0.076	1.18
01216LWD	675	17	37	38.3	1375	970	56.0	31.6	2970	3090	- 3.9	0.080	1.03
01066LWD	1000	9	26	52.6	2000	260	49.0	- 7.3	2800	3300	-15.2	0.097	----
11035LWD	940	14	79	54.2	1200	450	37.7	-43.8	3400	2675	27.1	0.086	1.17
11035LWD	760	14	99	46.9	1750	490	50.3	6.8	3370	3115	8.3	0.090	1.32
90915LWD	1200	30	170	75.5	1700	680	54.6	38.3	4000	3780	5.8	0.120	1.50
07075LWD	940	38	180	63.7	1100	810	45.7	39.4	4500	3070	46.6	0.098	0.94
07075LWD	900	---	18	46.5	1600	940	59.8	22.3	4240	3460	22.6	0.093	1.38
04285LWD	1100	---	140	66.7	1600	1500	75.6	11.8	4000	4340	- 7.8	0.121	1.28
02285LWD	1200	---	84	67.0	1200	560	40.8	64.2	3500	3045	15.0	0.100	1.28
02115LWD	1200	---	66	65.5	1200	1400	64.4	- 1.7	4200	3865	8.6	0.110	1.16
02115LWD	960	---	63	53.3	1425	1300	66.3	19.7	3960	3750	5.7	0.101	1.20
12094LWD	1500	---	76	81.3	580	----	----	----	5200	----	----	-----	----
10284LWD	240	---	29	14.4	590	210	18.2	20.9	1300	1070	21.6	0.030	----
10284LWD	150	---	8	8.2	425	285	16.9	51.6	1210	870	39.4	0.021	----
07066PSD	320	7	9	17.1	1300	50	28.5	40.0	1200	1690	-29.0	0.045	0.78
05036PSD	320	12	14	17.7	850	23	18.4	3.8	1600	1215	31.7	0.036	0.60
05036PSD	400	120	19	26.8	1000	84	23.2	-15.5	1620	1620	0.2	0.046	0.72
03016PSD	340	8	14	18.5	650	23	14.2	30.3	960	1040	- 7.7	0.032	0.52
01066PSD	1000	7	14	19.5	660	32	14.7	-32.7	1000	1070	- 6.5	0.034	0.55
11035PSD	710	22	36	39.5	1200	90	27.5	-43.6	2600	2055	26.5	0.065	1.14
11035PSD	600	26	37	34.2	1625	225	40.2	15.0	2530	2515	0.7	0.071	1.21
09015PSD	1200	20	22	62.7	2600	200	59.8	- 4.8	3500	4040	-13.4	0.110	----
07075PSD	850	13	17	44.5	----	200	----	----	2900	----	----	-----	----
07075PSD	460	---	16	24.3	1850	205	44.3	45.1	3320	2530	31.2	0.066	1.13
04285PSD	360	---	34	20.8	750	260	22.9	9.2	1700	1405	21.1	0.040	0.55
02245PSD	970	---	180	63.5	950	670	38.7	-64.2	3000	2770	8.3	0.093	0.88
02115PSD	830	---	170	55.7	1100	950	49.7	-12.1	3400	3050	11.5	0.092	0.89
02115PSD	560	---	152	40.7	950	1100	50.8	19.9	3020	2760	9.3	0.076	0.62
12094PSD	1100	---	40	58.3	980	1000	48.6	-20.1	4400	3120	41.0	0.093	1.03
10284PSD	1500	---	190	90.8	1700	2400	103.0	11.8	7300	5790	26.1	0.160	1.36
10284PSD	1640	---	1	82.0	1550	3000	116.8	29.8	6340	6190	2.4	0.156	1.40

Average Charge Imbalance: 9.2% (±29.0)
Average Mass Imbalance: 12.8% (±17.9)
Average Solubility Ratio: 1.04 (±0.29)

TABLE A-3. GYPSUM SOLUBILITY RATIO, CHARGE BALANCE, AND MASS BALANCE OF POND B LEACHATE AND SUPERNATE

	mg ℓ^{-1}			meq ℓ^{-1}	mg ℓ^{-1}		meq ℓ^{-1}	Charge Imbalance (%)	mg ℓ^{-1}		Mass Imbalance (%)	moles ℓ^{-1} Ionic Strength	Solubility Ratio
Sample	Ca	Na	Mg	Σ Cation	SO_4	Cl	Σ Anion		TDS	Σ Ions			
07206LWB2	800	110	26	46.9	970	660	38.8	-20.9	2800	2570	8.9	0.074	0.93
07206LWB1	620	23	8	32.7	1200	130	28.7	-13.9	1900	1980	- 4.0	0.060	1.07
07066LWB	630	84	27	37.4	750	930	41.8	10.5	2500	2420	3.3	0.064	0.65
05186LWB	500	90	29	31.3	850	500	31.8	1.6	2260	1970	14.8	0.054	0.68
05036LWB	450	23	11	24.5	1000	139	24.7	0.8	1690	1620	4.1	0.047	0.80
05036LWB	380	19	8	20.5	980	130	24.1	14.9	1400	1520	- 7.9	0.043	0.72
03016LWB	790	68	14	43.7	1200	290	33.2	-31.6	2400	2360	1.7	0.072	1.18
01216LWB	525	83	27	30.9	1100	520	37.6	17.8	2540	2255	12.6	0.061	0.83
01066LWB	840	110	25	48.9	890	630	36.3	-34.7	2700	2495	8.2	0.074	0.90
11035LWB	620	150	27	39.8	620	860	37.1	- 7.3	2600	2280	14.0	0.061	0.55
11035LWB	400	158	26	29.1	675	1100	45.0	35.5	2670	2360	13.2	0.055	0.54
09015LWB	570	160	3	35.8	360	880	32.3	-10.8	2500	1975	26.6	0.053	0.51
07075LWB	2300	70	57	122.8	490	940	36.7	-234.0	2600	3860	-32.6	0.144	---
04285LWB	530	---	35	29.4	530	460	24.0	-22.6	1800	1555	15.8	0.047	0.50
04225LWB	470	---	36	26.5	440	620	26.6	0.5	----	1565	-----	0.045	----
04155LWB	----	---	8	----	150	40	7.1	----	320	----	----	-----	----
07066PSB	160	5	2	8.4	330	23	7.5	-12.0	460	520	-11.5	0.015	----
05186PSB	300	11	4	15.8	775	130	19.8	20.2	1460	1210	20.8	0.034	0.53
05036PSB	370	15	5	19.6	950	82	22.1	11.3	1800	1420	26.8	0.040	0.71
05036PSB	400	15	5	21.1	1100	117	26.2	19.5	1780	1640	8.7	0.045	0.81
03016PSB	270	7	3	14.1	460	66	11.4	-23.7	770	805	- 4.3	0.024	----
01066PSB	320	9	4	16.7	----	150	----	----	880	----	----	-----	----
11035PSB	----	30	7	----	1200	320	34.0	----	2800	----	----	-----	----
11035PSB	580	28	10	31.0	1500	400	42.5	27.0	2670	2520	6.0	0.067	1.14
09015PSB	980	40	3	51.0	1700	380	46.1	-10.6	3000	3105	- 3.4	0.091	1.47
07085PSB	510	21	3	26.7	900	320	27.8	4.0	1800	1755	2.6	0.050	0.78
04285PSB	840	---	4	42.3	430	600	25.9	-63.7	2200	1875	17.4	0.060	0.52
04225PSB	1700	---	1	85.1	750	1500	57.9	-47.0	----	3950	---	0.122	0.93
04155PSB	2300	---	0.7	115.0	960	1500	62.2	-84.7	5600	4760	17.6	0.156	1.21
04155PSB	1740	---	--	87.0	1875	2400	106.7	18.4	5560	6015	- 7.6	0.160	1.46

Average Charge Imbalance: - 7.8% (±28.4)
Average Mass Imbalance: 6.1% (±13.2)
Average Solubility Ratio: 0.84 (±0.29)

TABLE A-4. GYPSUM SOLUBILITY RATIO, CHARGE BALANCE, AND MASS BALANCE OF POND C LEACHATE AND SUPERNATE

	mg ℓ^{-1}			meq ℓ^{-1}	mg ℓ^{-1}		meq ℓ^{-1}	Charge Imbalance (%)	mg ℓ^{-1}		Mass Imbalance (%)	moles ℓ^{-1}	Solubility Ratio
Sample	Ca	Na	Mg	Σ Cation	SO_4	Cl	Σ Anion		TDS	Σ Ions		Ionic Strength	
07066LWC	730	53	13	39.9	1600	260	40.7	2.0	2900	2660	9.0	0.076	1.37
05176LWC	800	---	9	40.8	----	810	----	----	3800	----	----	-----	----
05036LWC	700	102	12	40.4	1500	580	47.6	15.1	3750	2890	29.6	0.078	1.19
03016LWC	600	53	12	33.3	1550	380	42.9	22.4	3000	2590	15.8	0.070	1.17
01216LWC	575	143	9	42.0	1175	1050	54.1	22.4	3540	3090	14.6	0.076	0.79
01066LWC	790	18	9	41.1	870	1000	46.3	11.2	3500	2690	30.1	0.073	0.84
09015LWC	550	180	0.2	35.3	820	1100	48.1	26.6	3300	2650	24.5	0.064	0.62
07075LWC	650	150	8	39.7	190	1200	37.8	- 5.0	3200	2200	45.5	0.057	----
05055LWC	1900	---	0.1	95.0	----	2100	----	----	4100	4025	1.9	0.125	----
04285LWC	2000	---	5	100.4	750	2400	83.2	-20.6	4700	5155	- 8.8	0.150	0.86
04285LWC	1980	---	4	99.3	----	2560	----	----	4720	4620	2.2	-----	----
07066PSC	460	16	7	24.3	1100	500	37.0	34.3	2300	2080	10.6	0.054	0.80
05036PSC	560	120	18	34.7	1600	880	52.5	33.9	4300	2980	44.3	0.076	1.05
05036PSC	850	122	22	49.6	1500	680	50.4	1.6	4220	3175	33.0	0.088	1.29
03016PSC	1000	78	26	55.6	2300	430	60.0	7.3	3800	3840	- 1.0	0.108	----
01066PSC	600	29	8	32.0	890	180	23.6	-35.6	1800	1710	5.3	0.053	0.87
11035PSC	----	68	7	----	1100	430	35.0	----	3000	----	----	-----	----
11035PSC	600	68	9	33.8	1500	540	46.5	27.4	2960	2720	8.9	0.071	1.12
09015PSC	880	75	5	47.7	1700	500	49.5	3.6	3200	3160	1.3	0.089	1.50
07085PSC	450	49	3	23.9	600	440	24.9	4.0	2100	1545	35.9	0.043	0.51
05055PSC	480	---	0.4	24.0	200	240	10.9	-120.0	1500	920	63.0	0.032	----
04285PSC	590	---	0.2	29.5	200	560	19.9	-47.9	1600	1350	18.5	0.042	----
04285PSC	340	---	4	17.3	175	610	20.8	16.8	1560	1130	38.2	0.030	----

Average Charge Imbalance: 6.6% (±22.7)
Average Mass Imbalance: 18.0% (±16.2)
Average Solubility Ratio: 1.00 (±0.29)

TABLE A-5. GYPSUM SOLUBILITY RATIO, CHARGE BALANCE, AND MASS BALANCE OF POND E LEACHATE AND SUPERNATE

		mg ℓ^{-1}		meq ℓ^{-1}	mg ℓ^{-1}		meq ℓ^{-1}	Charge Imbalance	mg ℓ^{-1}		Mass Imbalance	moles ℓ^{-1} Ionic	Solubility
Sample	Ca	Na	Mg	Σ Cation	SO_4	Cl	Σ Anion	(%)	TDS	Σ Ions	(%)	Strength	Ratio
07066LWE	100	610	11	32.4	1000	350	30.7	- 5.5	2900	2070	40.0	0.045	----
03016LWE	28	560	1	25.9	1100	490	36.7	29.4	2800	2180	28.4	0.044	----
01216LWE	30	540	0.4	25.0	1075	520	37.0	32.4	2645	2165	22.2	0.043	----
01066LWE	49	600	3	28.7	1300	370	37.5	23.5	2700	2320	16.4	0.048	----
11035LWE	14	630	0.2	28.1	850	320	26.7	- 5.2	2700	1815	48.8	0.037	----
11035LWE	20	580	---	26.2	900	490	32.6	19.5	2690	1990	35.2	0.039	----
09015LWE	83	610	13	31.7	1100	25	23.6	-34.3	2700	1830	47.5	0.042	----
07075LWE	83	750	23	38.8	370	650	26.0	-49.2	2900	1875	54.7	0.039	----
07075LWE	20	705	1	43.3	800	740	37.5	-15.4	3200	2530	26.4	0.049	----
04285LWE	13	----	1	----	670	----	----	----	3400	----	----	-----	----
03195LWE	15	970	30	45.5	250	1850	57.3	20.7	2720	3115	-12.7	0.056	----
02115LWE	98	---	5	----	300	1000	34.4	----	2400	----	----	-----	----
07066PSE	300	38	3	16.9	770	22	16.7	- 1.2	1300	1130	15.0	0.033	----
05036PSE	410	110	6	25.8	1400	42	30.3	14.9	2300	1970	16.8	0.053	0.93
05036PSE	450	114	7	28.1	1400	110	32.3	12.9	2310	2080	11.0	0.056	0.97
03016PSE	500	170	2	32.6	1100	68	24.8	-31.5	2200	1840	19.6	0.053	0.89
01066PSE	400	56	4	22.7	850	40	18.8	-20.7	1200	1350	-11.1	0.040	0.69
11035PSE	360	190	4	26.6	1100	110	26.0	- 2.3	2400	1765	36.0	0.047	0.70
11035PSE	----	195	5	----	1375	170	33.4	----	2380	----	----	-----	----
09015PSE	400	180	3	28.1	1400	88	31.6	11.1	2200	2070	6.3	0.055	0.87
07075PSE	260	140	4	19.4	840	100	20.3	4.4	1700	1345	26.4	0.035	0.49
07075PSE	260	190	3	21.6	1000	245	27.7	22.3	1720	1700	1.3	0.042	0.51
04285PSE	170	---	1	----	390	110	11.2	----	1200	----	----	-----	----
02115PSE	----	---	0.3	----	220	170	9.4	----	1300	----	----	-----	----
02115PSE	460	440	30	44.6	250	365	15.5	-187.0	1440	1545	- 6.8	0.046	----

Average Charge Imbalance: 4.2% (±23.0)
Average Mass Imbalance: 19.3% (±19.5)
Average Solubility Ratio: 0.76(±0.19)

6.1 percent for Pond B to a high of 19.3 percent for Pond E, signifying that the TDS exceeded the sum of the ion concentrations of major species in more than 80 percent of the cases. A possible explanation for this bias is incomplete dehydration of hydrated salts during the drying operation of the TDS measurement. The spread of mass imbalances was rather large; the largest positive discrepancy was 54.7 percent, while the largest negative discrepancy was -32.6 percent. For most samples with large discrepancies, the results of one or more of the analyses.

For Pond A and Pond B samples, the average charge imbalances were negative, -17.5 percent and -7.8 percent, signifying cation surpluses (or anion deficits). For Ponds C, D, and E, the average anion surpluses (or cation deficits) were 12.8 percent, 6.6 percent, and 4.2 percent, respectively. Because the total anion concentrations were small for many samples, it is not unexpected that the spread of charge imbalances, which are reported as percentages of the total anion concentrations, was very large. The largest positive (anion surplus) discrepancy was 64.2 percent, while the largest negative (cation surplus) discrepancy was 234 percent. The latter result was coupled with a TDS deficit of -32.6 percent for the same sample. Therefore, it is not surprising to find for this sample that the reported calcium concentration of 2300 mg/ℓ is suspiciously high. Similar rationalizations of other large charge imbalances can also be made.

Calculations were made to compare the measured concentrations of calcium and sulfate with the predicted values on the basis of an assumed saturation with gypsum, $CaSO_4 \cdot 2H_2O$. The method of calculation takes into account the effect of ionic strength on the solubility product constant. A description of the method has been reported elsewhere.* In the last two columns of Tables A-1 through A-5, the ratios of the measured to the calculated gypsum concentrations have been tabulated, together with the ionic strengths obtained from the concentrations of major species. The spread of the solubility ratios is 0.5 to 1.5.† For each pond, the mean solubility ratio and the associated standard deviation were determined for all samples, both supernate and leachate. These ratios were 1.02, 1.04 and 1.00 for Ponds A, D, and C, respectively. For Ponds B and E, the average ratios were 0.83 and 0.76. Only 8 samples of supernate were included for Pond E since it was apparent from the analytical data for the leachate samples that the calcium concentrations were approximately 1/10 of the values necessary for gypsum saturation. For Pond B, also, the leachate samples are responsible for lowering the average value of the ratio. The average ratio for supernate samples from Pond B was 0.96.

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* J. Rossoff, et al., Disposal of By-Products from Nonregenerable Flue Gas Desulfurization Systems: Second Progress Report, EPA-600/7-77-052, U. S. Environmental Protection Agency, Research Triangle Park, North Carolina (May 1977).

† It should be noted that the calculated sulfate concentrations are determined from the measured calcium concentrations and vice versa; therefore, the computed solubility ratios have hyperbolic dependences on the accuracies of the analyses for sulfate and calcium concentrations. Thus, a spread of 0.5 to 1.5 in the solubility ratio will result from analytical errors of only 25 percent if the errors for both ion concentrations are in the same direction.

In Figures A-1 through A-5, the gypsum solubility ratios for each pond are plotted as functions of time after pond filling. In these figures, the ratios for supernate and leachate samples are plotted separately. The seasonal patterns of variation previously noted for TDS and concentrations of major species are evident also in the curves of Figures A-1 through A-5, although the correlations are most apparent for the pond supernates.

With the exception of some leachate samples from a possibly malfunctioning leachate well of Pond B, the data indicate that leachate samples from four of the ponds were saturated with gypsum. The leachate samples from Pond E were definitely not saturated. From the data, it appears that pond supernates were saturated with gypsum during dry seasonal periods and perhaps were not saturated during periods of cooler and more rainy weather. The supernate samples for Pond E were taken from the unfilled end of the pond. It is possible that the runoff from the surface of the chemically treated sludge which collected in the unfilled end of Pond E was not immediately saturated with gypsum.

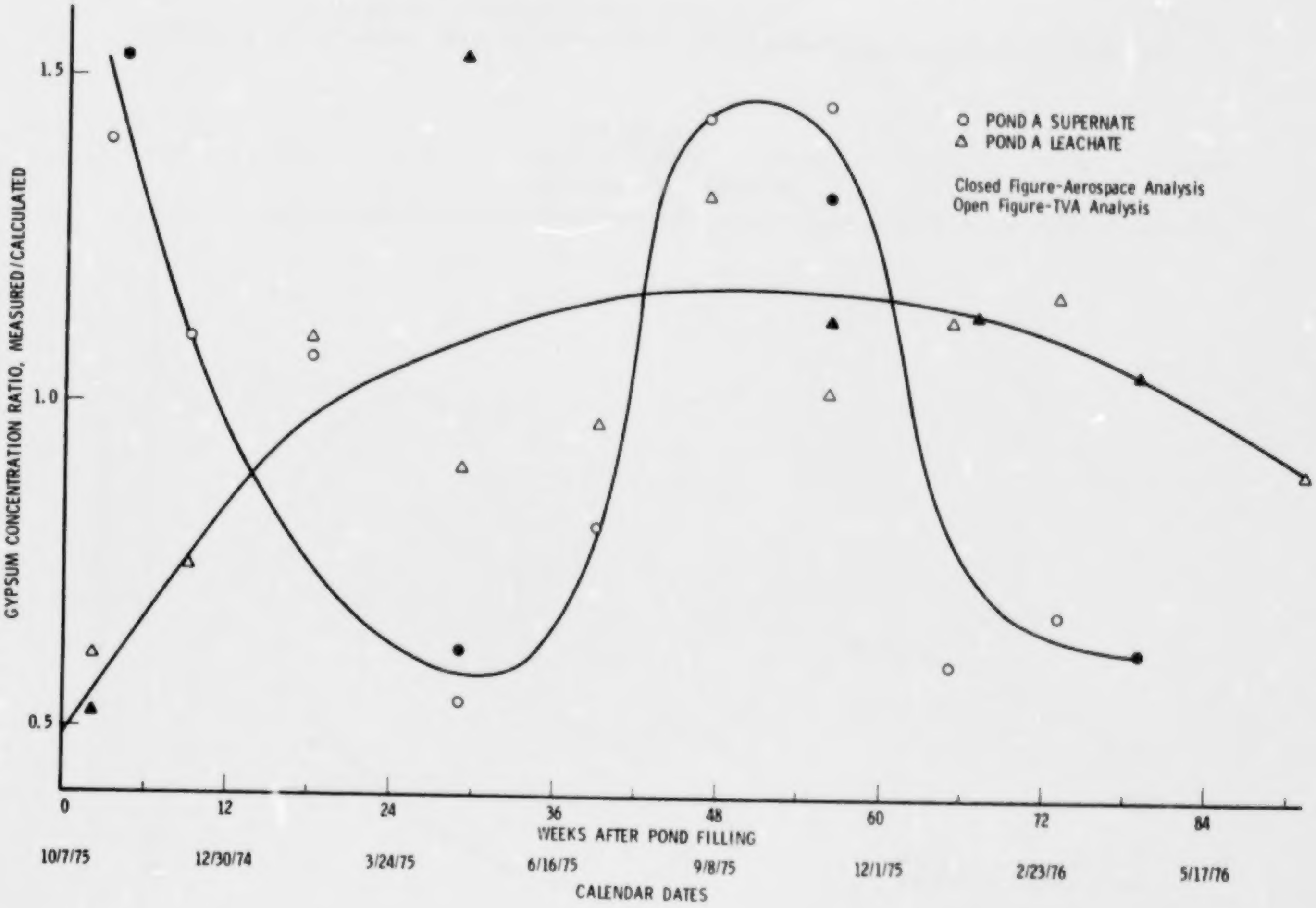

Figure A-1. Comparison of calculated and measured solubility of gypsum in Pond A leachate and supernate

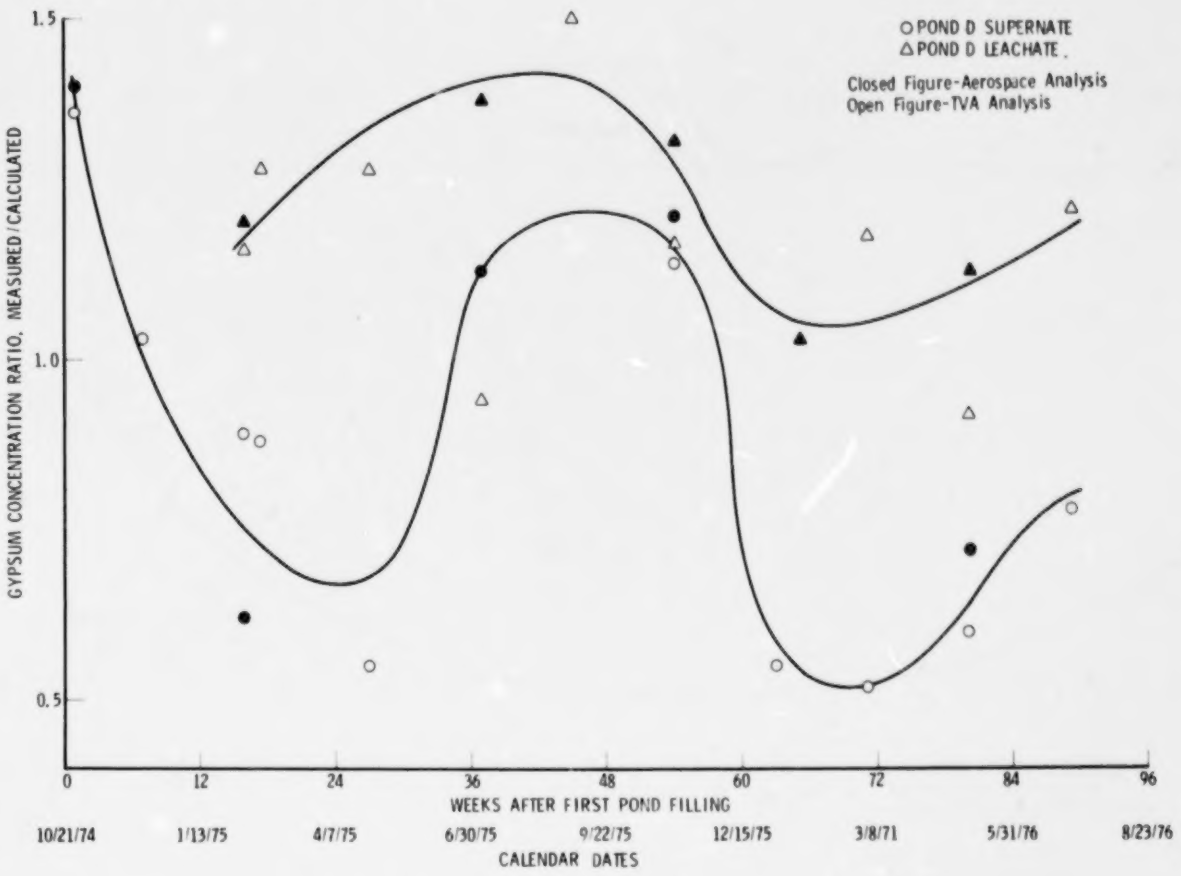

Figure A-2. Comparison of calculated and measured solubility of gypsum in Pond D leachate and supernate

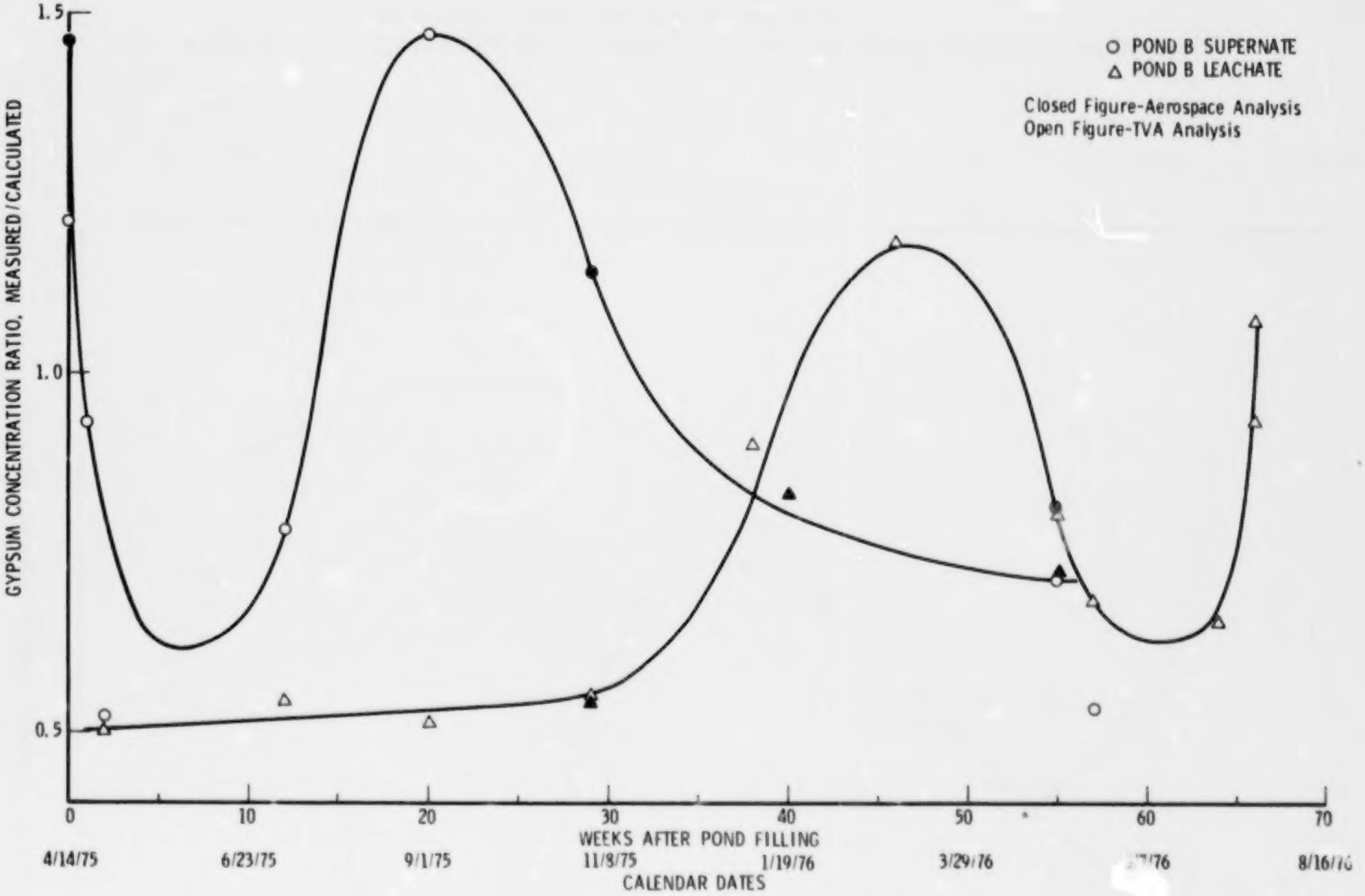

Figure A-3. Comparison of calculated and measured solubility of gypsum in Pond B leachate and supernate

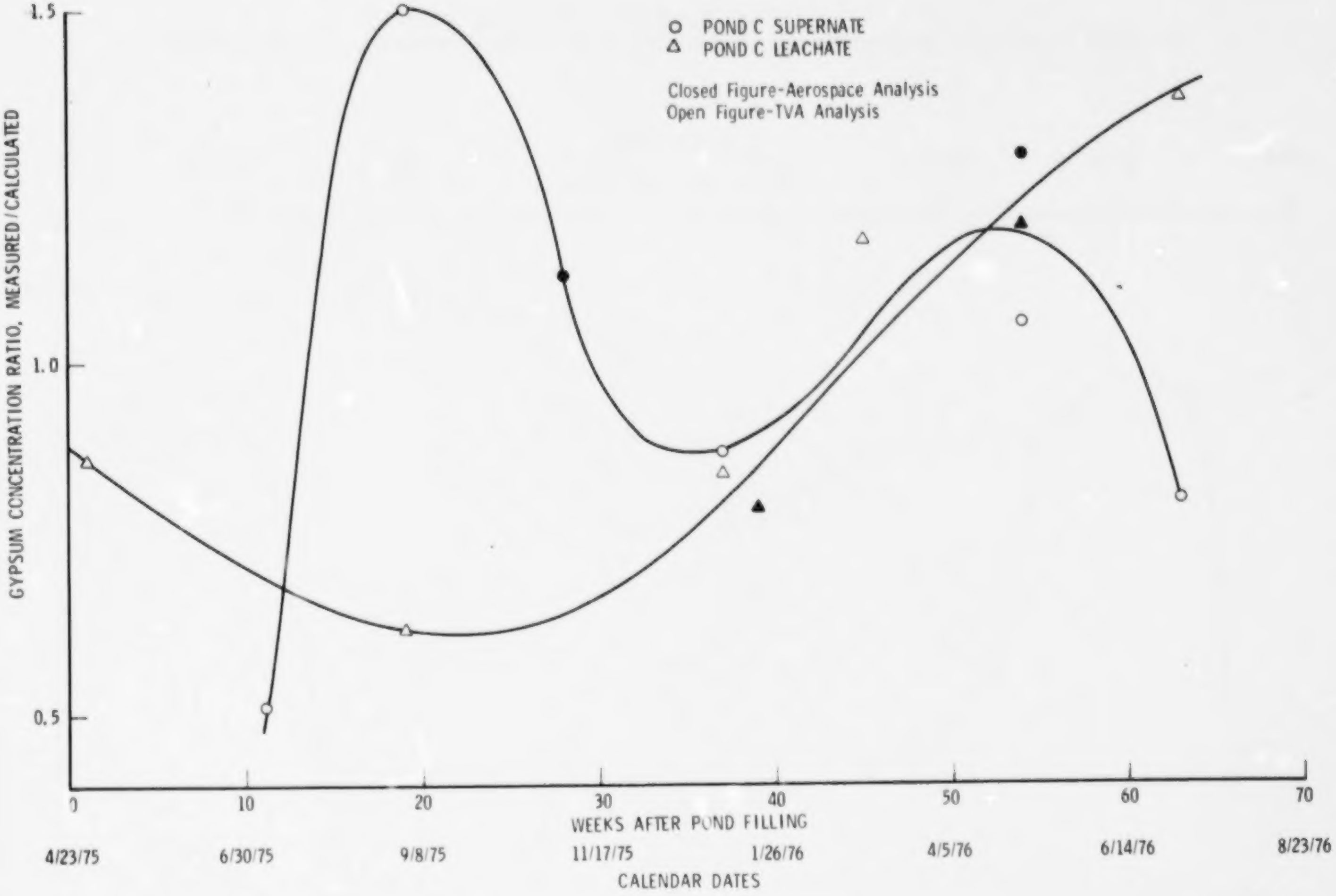

Figure A-4. Comparison of calculated and measured solubility of gypsum in Pond C leachate and supernate

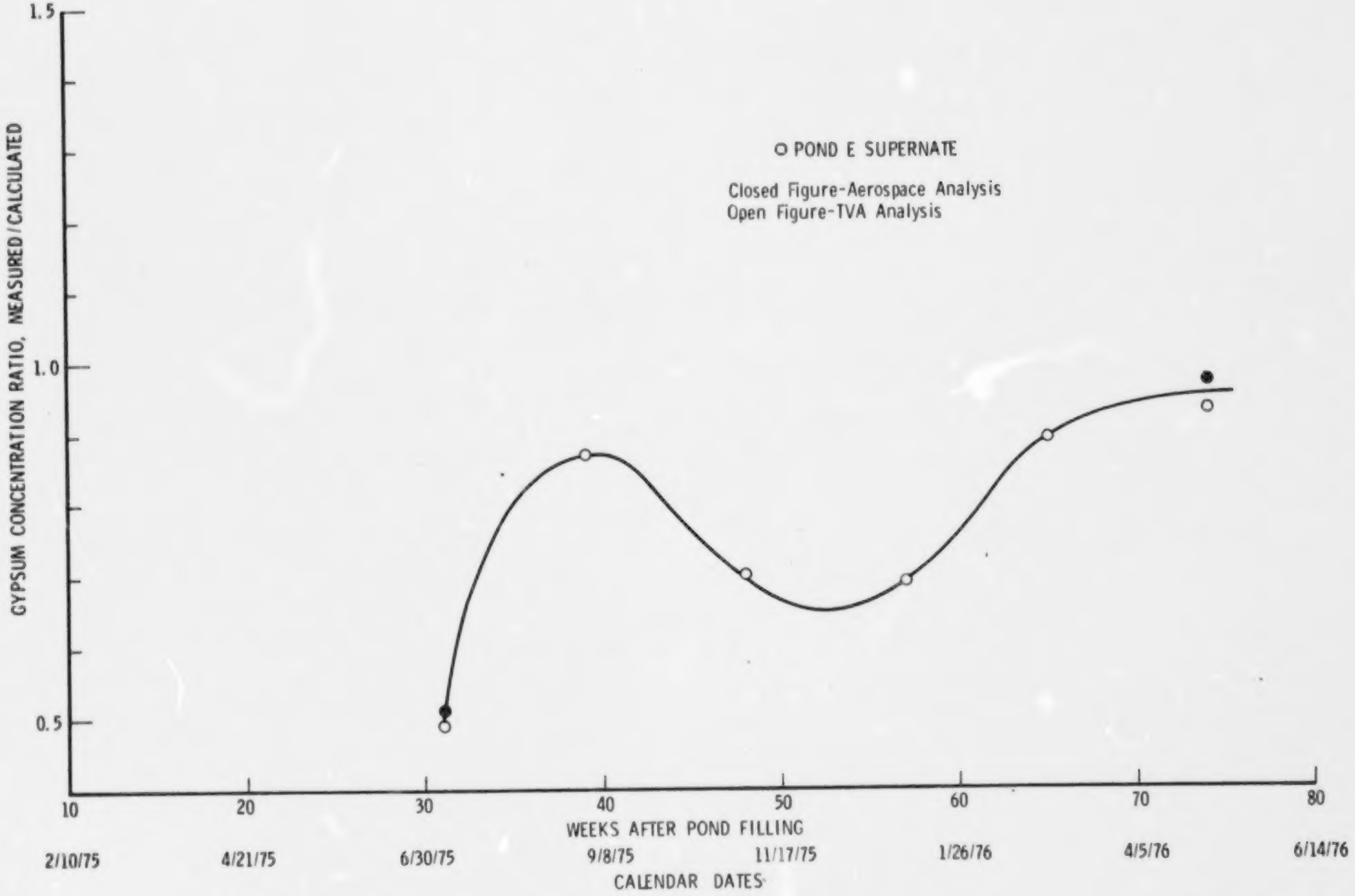

Figure A-5. Comparison of calculated and measured solubility of gypsum in Pond E leachate and supernate

APPENDIX B

RESULTS OF ANALYSES OF INPUT SLUDGE LIQUOR, FULL CHEMICAL CHARACTERIZATION OF POND LEACHATES, AND POND WATER SAMPLES

The results of the analyses of input sludge liquors are given in Table B-1. The chemical analyses of pond leachates, performed by The Aerospace Corporation, are presented in Table B-2.

The data contained in Table B-3 are the results of analyses by the Tennessee Valley Authority (TVA) and The Aerospace Corporation on samples of supernate, leachate, and groundwaters from the Shawnee flue gas desulfurization (FGD) sludge disposal evaluation ponds. The TVA and Aerospace results are tabulated separately, as indicated in the printout, for each category of water sample. All results are in milligrams per liter, except pH and conductivity. Conductivity is shown in micromhos per centimeter, and pH is in units. The pond identification and water category are printed at the top of each sheet, and the date each sample was taken is indicated by year, month, and day. A summation of all soluble constituents is shown at the bottom of each column for convenience of comparison with total dissolved solids (TDS). All data shown are presented as received from each laboratory, i. e., no corrections have been made for possible analytical errors.

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TABLE B-1. INPUT LIQUOR ANALYSIS

Pond[a]	Sludge Type	Moisture Content, %	pH	Concentration, mg/ℓ												
				Ca	SO4	Cl	SO_3	TDS[b]	As	B	Pb	Mg	Na	Se	Hg	COD[c]
A	Lime, filter cake	54	8.3	2100	1525	4600	4	8560	0.024	44	0.49	290	--	0.005	<0.0001	--
B	Limestone, clarifier underflow	62	8.9	1060	1875	1850	3	5160	0.004	97	<0.02	2.5	17	0.020	0.0024	140
C	Lime, centrifuge cake	45	8.9	2720	1575	4700	45	9240	0.002	34	<0.01	33	46	0.018	<0.0001	140
D	Limestone, clarifier underflow	62	9.2	1880	1500	2950	56	6750	--	93	<0.02	50	56	--	--	130
E	Limestone, clarifier underflow	62	9.4	1880	1400	2700	32	6190	0.004	80	<0.01	12	41	0.014	0.00033	110
F	Limestone, clarifier underflow, flyash remixed	53	12.2	1990	1100	2000	--	6700	0.002	76	<0.01	0.3	70	0.042	<0.0002	43
G	Lime, centrifuge cake, flyash remixed and layered	53	7.8	150	6600	3600	--	14000	0.14	93	<0.01	5000[d]	12	0.63	<0.0002	53

[a] Pond H to be analyzed.

[b] Total dissolved solids.

[c] Chemical oxygen demand.

[d] Magnesia added to lime absorbent.

TABLE B-2. FULL CHARACTERIZATION ANALYSIS OF POND LEACHATES[a]

Test Parameter	Ponds				
	A	B	C	D	E
Aluminum	9.2	3.0	2.6	3.8	0.2
Antimony	0.78	0.18	0.12	0.40	0.10
Beryllium	<0.004	<0.004	<0.004	<0.004	<0.004
Cadmium	0.002	<0.002	<0.002	<0.002	<0.002
Chromium	0.06	0.02	0.03	0.11	0.01
Cobalt	<0.05	<0.05	<0.05	<0.05	<0.05
Copper	<0.05	<0.05	<0.05	<0.05	<0.05
Calcium	1400	5.25	574	675	30
Arsenic	0.059	0.011	0.021	0.34	0.076
Boron	45	1.3	1.0	1.3	0.5
Iron	0.20	0.05	0.18	0.10	0.20
Lead	<0.01	0.01	<0.01	<0.01	<0.01
Magnesium	90	27	9	37	0.4
Mercury	<0.00008	0.0007	0.0012	0.00115	0.0007
Manganese	0.33	0.47	0.19	<0.05	<0.05
Molybdenum	2.0	0.11	0.45	0.34	0.32
Nickel	<0.05	<0.05	<0.05	<0.05	<0.05
Nitrogen	0.79	3.61	<0.010	0.74	0.52
Potassium	78	109	425	13	425
Selenium	0.014	0.009	0.022	0.004	0.005
Sodium	66	83	143	17	540
Silicon	--	--	0.48	--	0.60
Silver	0.036	0.022	0.038	0.012	0.010
Tin	0.32	<0.08	0.08	<0.08	0.08
Vanadium	0.08	<0.08	<0.08	0.08	0.29
Zinc	<0.05	<0.05	<0.05	<0.05	<0.05
Fluoride	2.9	0.05	0.4	3.0	1.75
Chloride	2300	520	1050	970	520
Carbonate	<40	<1	<20	<1	<50
Phosphate	<0.04	0.08	0.12	0.24	<0.04
Sulfate	1300	1100	1175	1375	1075

[a] Analysis by Aerospace on samples taken 1/21/76

TABLE B-3. ANALYSES OF POND WATERS

POND A SUPERNATE

WELL DESIG	PSA	PSA	PSA	PSA	PSA	PSA	PSA	PSA
DATE	741022.0000	741209.0000	750212.0000	750428.0000	750707.0000	750901.0000	751107.0000	760106.0000
REC NO.	100.0000	120.0000	140.0000	160.0000	180.0000	200.0000	220.0000	240.0000
PH	8.1000	8.2000	8.5000	8.0000	0.0000	8.2000	8.4000	7.7000
ALKALINITY	100.0000	60.0000	49.0000	43.0000	0.0000	34.0000	40.0000	36.0000
CHLORIDE	2000.0000	980.0000	630.0000	250.0000	300.0000	440.0000	330.0000	300.0000
COD	0.0000	60.0000	24.0000	14.0000	20.0000	29.0000	38.0000	27.0000
COND	8000.0000	4600.0000	3200.0000	1600.0000	2500.0000	3600.0000	3700.0000	1800.0000
TDS	7100.0000	4300.0000	2800.0000	1600.0000	2300.0000	3600.0000	3500.0000	1900.0000
TSS	18.0000	27.0000	6.0000	7.0000	14.0000	6.0000	20.0000	31.0000
SULFATE	1400.0000	1100.0000	1100.0000	570.0000	810.0000	1900.0000	1300.0000	540.0000
ARSENIC	.0300	.0150	.0050	.0050	.0060	.1200	.0190	.0050
BORON	16.0000	2.2000	8.6000	0.0000	5.3000	8.3000	14.0000	0.0000
CALCIUM	2000.0000	1100.0000	880.0000	480.0000	640.0000	1200.0000	1200.0000	670.0000
LEAD	.0100	.0100	.0100	.0160	.0100	.0200	.0100	.0230
MAGNESIUM	140.0000	71.0000	48.0000	20.0000	21.0000	26.0000	34.0000	19.0000
MERCURY	.0005	.0002	.0003	.0002	.0017	.0002	.0002	.0014
SELENIUM	.0020	.0020	.0020	.0020	.0020	.0020	.0010	.0020
SULFITE	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
SODIUM	0.0000	0.0000	0.0000	0.0000	16.0000	23.0000	27.0000	20.0000
TOTAL ELEM	5556.0425	3253.2272	2666.8173	1320.0232	1792.3197	3597.4422	2905.0302	1549.0314

POND A SUPERNATE

WELL DESIG	PSA	PSA
DATE	760301.0000	760706.0000
REC NO.	260.0000	280.0000
PH	7.8000	7.4000
ALKALINITY	26.0000	84.0000
CHLORIDE	130.0000	42.0000
COD	53.0000	32.0000
COND	1500.0000	930.0000
TDS	1500.0000	1800.0000
TSS	16.0000	7.0000
SULFATE	690.0000	320.0000
ARSENIC	.0100	.0150
BORON	3.8000	2.0000
CALCIUM	540.0000	240.0000
LEAD	.0100	.0100
MAGNESIUM	17.0000	12.0000
MERCURY	.0002	.0002
SELENIUM	.0040	.0030
SULFITE	0.0000	0.0000
SODIUM	15.0000	8.9000
TOTAL ELEM	1395.8242	624.9282

POND A SUPERNATE --- AEROSPACE ---

WELL DESIG	PSA	PSA	PSA	PSA
DATE	741028.0000	750428.0000	751103.0000	760415.0000
REC NO.	340.0000	360.0000	380.0000	400.0000
PH	7.7100	7.6800	7.1300	7.0800
ALKALINITY	59.0000	43.0000	41.0000	47.0000
CHLORIDE	1600.0000	390.0000	710.0000	350.0000
COD	0.0000	50.0000	65.0000	0.0000
COND	7800.0000	1800.0000	3440.0000	2080.0000
TDS	5850.0000	1540.0000	3870.0000	2080.0000
TSS	10.0000	0.0000	0.0000	0.0000
SULFATE	1500.0000	650.0000	1675.0000	750.0000
ARSENIC	0.0000	.0050	.0040	.0010
BORON	22.8000	1.9000	8.8000	6.3000
CALCIUM	1480.0000	540.0000	760.0000	455.0000
LEAD	.0930	.1000	.0100	.0100
MAGNESIUM	.6000	4.6000	33.0000	18.0000
MERCURY	0.0000	.0002	.0003	.0013
SELENIUM	0.0000	.0070	.0060	.0310
SULFITE	1.3000	.2000	.1000	0.0000
SODIUM	0.0000	0.0000	30.0000	18.0000
TOTAL ELEM	4604.7930	1586.8122	3216.9203	1597.3433

POND A LEACHATE

WELL DESIG	LWA	LWA	LWA	LWA	LWA	LWA	LWA	LWA
DATE	741015.0000	741209.0000	750211.0000	750428.0000	750707.0000	750901.0000	751103.0000	760106.0000
REC NO.	1040.0000	460.0000	480.0000	500.0000	520.0000	540.0000	560.0000	580.0000
PH	7.0000	6.8000	7.6000	7.6000	7.5000	6.8000	7.4000	8.5000
ALKALINITY	410.0000	310.0000	150.0000	61.0000	62.0000	260.0000	230.0000	110.0000
CHLORIDE	36.0000	1800.0000	2900.0000	3300.0000	3500.0000	3300.0000	3000.0000	2200.0000
COD	0.0000	90.0000	100.0000	150.0000	1400.0000	170.0000	58.0000	180.0000
COND	1200.0000	6300.0000	9500.0000	9800.0000	10000.0000	10000.0000	11000.0000	9200.0000
TDS	830.0000	5400.0000	6600.0000	7700.0000	8100.0000	7800.0000	7600.0000	6000.0000
TSS	150.0000	170.0000	0.0000	31.0000	100.0000	330.0000	40.0000	180.0000
SULFATE	230.0000	790.0000	1100.0000	1000.0000	980.0000	1300.0000	940.0000	1000.0000
ARSENIC	.0050	.0050	.0050	.0050	.0200	.0080	.0750	.1200
BORON	.3800	2.2000	28.0000	31.0000	42.0000	48.0000	36.0000	0.0000
CALCIUM	160.0000	1200.0000	2100.0000	1600.0000	2300.0000	3000.0000	2700.0000	2500.0000
LEAD	.0100	.0100	.0480	.0320	.0620	.0150	.1200	.1100
MAGNESIUM	44.0000	120.0000	98.0000	72.0000	82.0000	120.0000	81.0000	74.0000
MERCURY	.0019	.0012	.0010	.0018	.0067	.0009	.0009	.0013
SELENIUM	.0020	.0020	.0020	.0120	.0130	.0040	.0010	.0020
SULFITE	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
SODIUM	0.0000	0.0000	0.0000	0.0000	0.0000	96.0000	120.0000	71.0000
TOTAL ELEM	470.3989	3912.2182	6226.0560	6003.0508	6904.1017	7864.0279	6877.1969	5845.2333

POND A LEACHATE

WELL DESIG	LWA	LWA	LWA
DATE	760301.0000	760706.0000	761109.0000
REC NO.	600.0000	620.0000	640.0000
PH	8.3000	7.4000	7.2000
ALKALINITY	89.0000	110.0000	58.0000
CHLORIDE	1800.0000	1200.0000	810.0000
COD	48.0000	46.0000	47.0000
COND	7600.0000	3800.0000	3200.0000
TDS	5400.0000	4100.0000	4000.0000
TSS	21.0000	93.0000	910.0000
SULFATE	1200.0000	1100.0000	2200.0000
ARSENIC	.0600	.0100	.0120
BORON	46.0000	21.0000	21.0000
CALCIUM	1500.0000	850.0000	910.0000
LEAD	.3200	.0190	.0380
MAGNESIUM	82.0000	130.0000	91.0000
MERCURY	.0005	.0002	.0002
SELENIUM	.0060	.0030	.0110
SULFITE	0.0000	-0.0000	0.0000
SODIUM	64.0000	140.0000	81.0000
TOTAL ELEM	4692.3865	3441.0322	4113.0612

POND A LEACHATE --- AEROSPACE ---

WELL DESIG	LWA	LWA	LWA	LWA	LWA	LWA
DATE	741014.0000	750428.0000	751103.0000	760121.0000	760415.0000	761109.0000
REC NO.	760.0000	780.0000	800.0000	820.0000	840.0000	860.0000
PH	7.8300	7.7100	7.2600	8.1600	7.5900	7.4000
ALKALINITY	49.0000	67.0000	177.0000	68.0000	60.0000	49.6000
CHLORIDE	840.0000	2100.0000	3400.0000	2300.0000	1500.0000	710.0000
COD	110.0000	0.0000	200.0000	150.0000	0.0000	0.0000
COND	3300.0000	9800.0000	9090.0000	6250.0000	5000.0000	4030.0000
TDS	2460.0000	7292.0000	7560.0000	5860.0000	4340.0000	3596.0000
TSS	870.0000	0.0000	0.0000	0.0000	0.0000	0.0000
SULFATE	700.0000	1425.0000	1250.0000	1300.0000	1200.0000	1420.0000
ARSENIC	0.0000	.0050	.0040	.0590	.0010	.0020
BORON	10.2000	25.0000	47.0000	45.0000	40.0000	38.0000
CALCIUM	465.0000	2040.0000	2080.0000	1400.0000	1000.0000	930.0000
LEAD	.0270	.4400	0.0000	.0100	.0100	.0400
MAGNESIUM	49.3000	14.8000	129.0000	90.0000	53.0000	81.0000
MERCURY	0.0000	.0003	.0003	.0001	.0009	.0001
SELENIUM	0.0000	.0080	.0080	.0140	.0330	.0040
SULFITE	8.6000	0.0000	.4000	0.0000	0.0000	0.0000
SODIUM	0.0000	0.0000	12.5000	66.0000	50.0000	82.0000
TOTAL ELEM	2073.1270	5605.2533	6918.9123	5201.0831	3843.0449	3261.0461

POND A GROUND WELL 1

WELL DESIG	GWA1	GWA1	GWA1	GWA1	GWA1	GWA1	GWA1	GWA1
DATE	740709.0000	740722.0000	740729.0000	740805.0000	740903.0000	741007.0000	741015.0000	741028.0000
REC NO.	920.0000	940.0000	960.0000	980.0000	1000.0000	1020.0000	440.0000	1060.0000
PH	6.9000	6.9000	6.8000	6.8000	6.9000	7.2000	6.6000	7.0000
ALKALINITY	390.0000	410.0000	410.0000	430.0000	370.0000	380.0000	490.0000	390.0000
CHLORIDE	31.0000	34.0000	34.0000	36.0000	35.0000	37.0000	590.0000	30.0000
COD	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
COND	1100.0000	390.0000	1100.0000	0.0000	0.0000	0.0000	3100.0000	1200.0000
TDS	730.0000	770.0000	880.0000	840.0000	790.0000	820.0000	2200.0000	770.0000
TSS	10.0000	40.0000	35.0000	230.0000	0.0000	83.0000	210.0000	49.0000
SULFATE	140.0000	240.0000	240.0000	280.0000	210.0000	260.0000	500.0000	180.0000
ARSENIC	.0050	.0050	.0050	.0050	.0050	.0050	.0050	.0050
BORON	.2200	.2900	.3500	.3700	0.0000	.3200	6.8000	.2500
CALCIUM	120.0000	130.0000	160.0000	190.0000	160.0000	160.0000	560.0000	120.0000
LEAD	.2400	.0580	.0950	.0680	0.0000	.0100	.0100	.0100
MAGNESIUM	6.8000	42.0000	47.0000	56.0000	48.0000	49.0000	47.0000	41.0000
MERCURY	.0002	.0010	.0470	.0013	.0002	.0003	.0003	.0002
SELENIUM	.0020	.0020	.0020	.0020	.0020	.0020	.0020	.0020
SULFITE	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
SODIUM	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
TOTAL ELEM	298.2672	446.3560	501.4990	562.4463	453.0072	506.3373	1703.8173	371.2672

POND A GROUND WELL 1

WELL DESIG	GWA1	GWA1	GWA1	GWA1	GWA1	GWA1	GWA1	GWA1
DATE	741209.0000	750211.0000	750428.0000	750707.0000	750901.0000	751103.0000	760106.0000	760301.0000
REC NO.	1080.0000	1100.0000	1120.0000	1140.0000	1160.0000	1180.0000	1200.0000	1220.0000
PH	6.5000	6.7000	6.9000	6.5000	6.8000	7.3000	6.5000	6.6000
ALKALINITY	440.0000	380.0000	210.0000	300.0000	280.0000	200.0000	350.0000	250.0000
CHLORIDE	45.0000	25.0000	94.0000	36.0000	41.0000	46.0000	40.0000	33.0000
COD	16.0000	66.0000	19.0000	34.0000	17.0000	27.0000	0.0000	0.0000
COND	1100.0000	1000.0000	930.0000	980.0000	960.0000	1000.0000	730.0000	740.0000
TDS	700.0000	670.0000	700.0000	650.0000	690.0000	670.0000	540.0000	420.0000
TSS	0.0000	0.0000	81.0000	420.0000	21.0000	20.0000	310.0000	170.0000
SULFATE	110.0000	140.0000	150.0000	150.0000	150.0000	160.0000	130.0000	140.0000
ARSENIC	.0050	.0050	.0050	.0050	.0050	.0050	.0050	.0300
BORON	.4800	.3800	.4900	.4600	1.3000	.3700	0.0000	.3600
CALCIUM	110.0000	150.0000	160.0000	110.0000	130.0000	94.0000	120.0000	98.0000
LEAD	.0100	.0400	.0400	.0450	.0180	.0160	.0370	.0100
MAGNESIUM	32.0000	36.0000	36.0000	36.0000	38.0000	48.0000	32.0000	31.0000
MERCURY	.0004	.0035	.0028	.0170	.0013	.0013	.0007	.0016
SELENIUM	.0020	.0020	.0020	.0020	.0020	.0010	.0020	.0040
SULFITE	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
SODIUM	0.0000	0.0000	0.0000	64.0000	68.0000	68.0000	62.0000	56.0000
TOTAL ELEM	297.4974	351.4305	440.5398	396.5290	428.3263	416.3933	384.0447	358.4056

POND A GROUND WELL 1--- AEROSPACE ---

WELL DESIG	GWA1	GWA1	GWA1	GWA1	GWA1
DATE	740904.0000	741028.0000	750415.0000	750428.0000	751103.0000
REC NO.	1260.0000	1280.0000	1340.0000	1300.0000	1320.0000
PH	8.1800	7.9400	7.1200	6.9300	7.5000
ALKALINITY	179.0000	0.0000	250.0000	286.0000	314.0000
CHLORIDE	84.0000	86.0000	86.0000	86.0000	100.0000
COD	40.0000	0.0000	0.0000	95.0000	40.0000
COND	910.0000	860.0000	690.0000	910.0000	820.0000
TDS	620.0000	588.0000	480.0000	440.0000	740.0000
TSS	0.0000	130.0000	0.0000	0.0000	0.0000
SULFATE	8.0000	175.0000	120.0000	250.0000	150.0000
ARSENIC	.0050	.0040	.0310	.0050	.0060
BORON	.4000	.4000	1.8000	.3000	.5000
CALCIUM	40.0000	40.0000	57.0000	68.0000	72.0000
LEAD	.0500	.0530	.0100	.0700	.0200
MAGNESIUM	72.0000	34.2000	31.0000	33.0000	40.0000
MERCURY	.0008	0.0000	.0003	.0005	.0006
SELENIUM	.0040	.0020	.0130	.0150	.0080
SULFITE	.4000	.1000	0.0000	.5000	.3000
SODIUM	0.0000	0.0000	60.0000	0.0000	78.0000
TOTAL ELEM	204.8598	335.7590	355.8548	437.8905	440.8346

POND A GROUND WELL 2

WELL DESIG	GWA2	GWA2	GWA2	GWA2	GWA2	GWA2	GWA2	GWA2
DATE	740722.0000	740729.0000	740805.0000	740903.0000	741007.0000	741022.0000	741028.0000	741209.0000
REC NO.	1380.0000	1400.0000	1420.0000	1440.0000	1460.0000	1480.0000	1500.0000	1520.0000
PH	7.3000	7.1000	7.2000	7.2000	7.3000	7.7000	7.7000	8.0000
ALKALINITY	670.0000	640.0000	590.0000	570.0000	490.0000	400.0000	480.0000	400.0000
CHLORIDE	27.0000	26.0000	26.0000	27.0000	26.0000	24.0000	22.0000	30.0000
COD	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	16.0000
COND	1100.0000	870.0000	0.0000	0.0000	0.0000	990.0000	970.0000	850.0000
TDS	790.0000	750.0000	720.0000	680.0000	610.0000	610.0000	580.0000	550.0000
TSS	100.0000	39.0000	31.0000	0.0000	62.0000	43.0000	110.0000	18.0000
SULFATE	22.0000	32.0000	28.0000	21.0000	42.0000	40.0000	46.0000	64.0000
ARSENIC	.0050	.0050	.0050	.0050	.0050	.0050	.0050	.0050
BORON	.1400	.1600	.1600	.1200	.1200	.1000	.1000	.2300
CALCIUM	100.0000	120.0000	120.0000	100.0000	94.0000	100.0000	63.0000	59.0000
LEAD	.0850	.0520	.0890	.0140	.0100	.0100	.0100	.0100
MAGNESIUM	65.0000	66.0000	63.0000	54.0000	51.0000	52.0000	46.0000	38.0000
MERCURY	.0002	.1900	.0015	.0002	.0002	.0004	.0002	.0002
SELENIUM	.0020	.0020	.0020	.0020	.0020	.0020	.0020	.0020
SULFITE	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
SODIUM	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
TOTAL ELEM	214.2322	244.4090	237.2575	202.1412	213.1372	216.1174	177.1172	191.2472

POND A GROUND WELL 2

WELL DESIG	GWA2	GWA2	GWA2	GWA2	GWA2	GWA2	GWA2	GWA2
DATE	750211.0000	750428.0000	750707.0000	750901.0000	751107.0000	760106.0000	760301.0000	760503.0000
REC NO.	1540.0000	1560.0000	1580.0000	1600.0000	1620.0000	1640.0000	1660.0000	1680.0000
PH	7.4000	7.4000	7.1000	0.0000	7.5000	7.2000	7.0000	7.6000
ALKALINITY	74.0000	58.0000	100.0000	0.0000	150.0000	110.0000	86.0000	28.0000
CHLORIDE	18.0000	16.0000	20.0000	0.0000	13.0000	9.0000	8.0000	180.0000
COD	21.0000	8.0000	47.0000	10.0000	10.0000	11.0000	6.0000	40.0000
COND	500.0000	420.0000	440.0000	0.0000	470.0000	350.0000	330.0000	2500.0000
TDS	330.0000	320.0000	530.0000	0.0000	350.0000	240.0000	220.0000	2600.0000
TSS	0.0000	89.0000	19000.0000	0.0000	12.0000	50.0000	10.0000	7.0000
SULFATE	130.0000	88.0000	190.0000	0.0000	88.0000	65.0000	75.0000	1200.0000
ARSENIC	.0050	.0050	.0050	.0050	.0050	.0050	.0100	.1200
BORON	.2600	.3400	.3300	.8000	.3100	0.0000	.1700	8.3000
CALCIUM	40.0000	32.0000	110.0000	51.0000	45.0000	38.0000	28.0000	470.0000
LEAD	.0280	.0160	.2000	.0220	.0170	.0300	.0490	.0100
MAGNESIUM	18.0000	12.0000	4.2000	15.0000	26.0000	14.0000	14.0000	14.0000
MERCURY	.0004	.0011	.0015	.0006	.0002	.0007	.0002	.0002
SELENIUM	.0020	.0020	.0020	.0020	.0010	.0020	.0040	.0080
SULFITE	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
SODIUM	0.0000	0.0000	28.0000	32.0000	30.0000	22.0000	19.0000	15.1000
TOTAL ELEM	206.2954	148.3641	352.7385	98.8296	202.3332	148.0377	144.2332	1887.5382

POND A GROUND WELL 2--- AEROSPACE ---

WELL DESIG	GWA2	GWA2	GWA2	GWA2	GWA2
DATE	740904.0000	741028.0000	750428.0000	751103.0000	760415.0000
REC NO.	1700.0000	1720.0000	1740.0000	1760.0000	1780.0000
PH	8.7100	8.7200	7.4000	7.7200	7.4800
ALKALINITY	389.0000	330.0000	55.0000	155.0000	82.0000
CHLORIDE	64.0000	73.0000	43.0000	56.0000	44.0000
COD	20.0000	40.0000	5.0000	40.0000	0.0000
COND	770.0000	690.0000	370.0000	420.0000	290.0000
TDS	488.0000	440.0000	248.0000	344.0000	190.0000
TSS	0.0000	0.0000	0.0000	0.0000	0.0000
SULFATE	22.0000	51.0000	175.0000	90.0000	70.0000
ARSENIC	.0050	.0050	.0050	.0060	.0010
BORON	.4000	.2000	.1000	.1000	1.5000
CALCIUM	15.0000	15.0000	28.0000	32.0000	27.0000
LEAD	.0400	.0300	.0200	.0200	.0100
MAGNESIUM	74.0000	70.0000	13.4000	19.0000	11.0000
MERCURY	.0005	0.0000	.0004	.0002	.0008
SELENIUM	.0050	.0020	.0040	.0020	.0060
SULFITE	.9000	.9000	.2000	.2000	0.0000
SODIUM	0.0000	0.0000	0.0000	33.0000	22.0000
TOTAL ELEM	176.3505	210.1370	259.7294	230.3282	175.5198

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POND B SUPERNATE

WELL DESIG          PSB          PSB          PSB          PSB          PSB          PSB          PSB          PSB
DATE        750415.0000  750428.0000  750708.0000  750901.0000  751103.0000  760106.0000  760301.0000  760503.0000
REC NO.       1800.0000    1840.0000    1860.0000    1880.0000    1900.0000    1920.0000    1940.0000    1960.0000
PH              11.5000       8.7000       8.4000       8.6000       8.3000       7.1000       7.5000       7.4000
ALKALINITY    1300.0000      79.0000      30.0000      47.0000      34.0000      29.0000      30.0000      34.0000
CHLORIDE      1500.0000     600.0000     320.0000     380.0000     320.0000     150.0000      66.0000      82.0000
COD             60.0000      25.0000      25.0000      54.0000      43.0000       8.0000      11.0000      42.0000
COND          8600.0000    2600.0000    2200.0000    3400.0000    2900.0000    1500.0000     900.0000    1800.0000
TDS           5600.0000    2200.0000    1800.0000    3000.0000    2800.0000     880.0000     770.0000    1800.0000
TSS            160.0000       8.0000       4.0000      17.0000      17.0000      11.0000       2.0000      15.0000
SULFATE        960.0000     430.0000     900.0000    1700.0000    1200.0000      94.0000     460.0000     950.0000
ARSENIC           .0050        .0050        .0100        .0050        .0200        .0050        .0100        .0200
BORON           63.0000      24.0000      10.0000       7.5000        .5700       0.0000        .9400       2.1000
CALCIUM       2300.0000     840.0000     510.0000     980.0000     580.0000     320.0000     270.0000     370.0000
LEAD              .0100        .0400        .0100        .0250        .0100        .0100        .0100        .0100
MAGNESIUM         .2000       4.2000       2.8000       3.2000       6.9000       3.9000       2.7000       4.8000
MERCURY           .0002        .0002        .0003        .0002        .0002        .0002        .0002        .0002
SELENIUM          .0900        .0020        .0050        .0030        .0010        .0020        .0040        .0040
SULFITE          0.0000       0.0000       0.0000       0.0000       0.0000       0.0000       0.0000       0.0000
SODIUM           0.0000       0.0000      21.0000      40.0000      30.0000       9.3000       6.7000      15.0000
TOTAL ELEM    4823.3052    1898.2472    1763.8253    3110.7332    2137.5012     577.2172     806.3642    1423.9342


POND B SUPERNATE

WELL DESIG          PSB
DATE        760706.0000
REC NO.       1980.0000
PH               7.1000
ALKALINITY      36.0000
CHLORIDE        23.0000
COD             25.0000
COND           700.0000
TDS            460.0000
TSS              4.0000
SULFATE        330.0000
ARSENIC           .0050
BORON            1.0000
CALCIUM        160.0000
LEAD              .0100
MAGNESIUM        2.1000
MERCURY           .0002
SELENIUM          .0010
SULFITE          0.0000
SODIUM           5.1000
TOTAL ELEM     521.2162
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POND B SUPERNATE    --- AEROSPACE ---

WELL DESIG          PSB          PSB          PSB          PSB
DATE         750415.0000  751103.0000  760503.0000  760518.0000
REC NO.        2040.0000    2060.0000    2080.0000    2100.0000
PH               12.1500       6.7900       6.7000       7.3500
ALKALINITY     1294.0000      35.0000      34.0000      30.0000
CHLORIDE       2400.0000     400.0000     117.0000     130.0000
COD               0.0000      50.0000       0.0000       0.0000
COND           7900.0000    2700.0000    1810.0000    1420.0000
TDS            5560.0000    2670.0000    1760.0000    1460.0000
TSS               0.0000       0.0000       0.0000       0.0000
SULFATE        1875.0000    1500.0000    1100.0000     775.0000
ARSENIC            .0040        .0100        .0120        .0010
BORON            86.0000       4.4000       3.0000       1.8000
CALCIUM        1740.0000     580.0000     400.0000     300.0000
LEAD               .3900        .0100        .0100        .0100
MAGNESIUM         0.0000      10.0000       5.0000       4.0000
MERCURY            .0001        .0004        .0006        .0012
SELENIUM           .0690        .0180        .0650        .0360
SULFITE          70.0000        .2000       0.0000       0.0000
SODIUM           34.0000      28.0000      15.0000      11.0000
TOTAL ELEM     6205.4831    2522.6384    1640.0876    1221.8482
```

POND B LEACHATE

WELL DESIG	LWB	LWB	LWB	LWB	LWB	LWB	LWB	LWB
DATE	750211.0000	750415.0000	750422.0000	750428.0000	750707.0000	750901.0000	751103.0000	760106.0000
REC NO.	2120.0000	2140.0000	2160.0000	2180.0000	2200.0000	2220.0000	2240.0000	2280.0000
PH	8.3000	0.0000	6.0000	6.9000	10.1000	9.1000	6.2000	7.3000
ALKALINITY	350.0000	0.0000	8.0000	22.0000	250.0000	70.0000	8.0000	39.0000
CHLORIDE	110.0000	0.0000	620.0000	460.0000	940.0000	880.0000	860.0000	630.0000
COD	48.0000	14.0000	92.0000	42.0000	1200.0000	98.0000	35.0000	13.0000
COND	1200.0000	0.0000	0.0000	0.0000	3400.0000	3900.0000	3700.0000	3100.0000
TDS	440.0000	0.0000	0.0000	1800.0000	2600.0000	2500.0000	2600.0000	2700.0000
TSS	0.0000	0.0000	0.0000	18.0000	12000.0000	2600.0000	6.0000	130.0000
SULFATE	85.0000	0.0000	440.0000	530.0000	490.0000	360.0000	620.0000	890.0000
ARSENIC	.0070	.0050	.0100	.0500	.0400	.0200	.0250	.0150
BORON	.9600	.1000	50.0000	0.0000	3.2000	.9000	.2600	0.0000
CALCIUM	64.0000	290.0000	470.0000	530.0000	2300.0000	570.0000	620.0000	840.0000
LEAD	.0580	.0900	.0240	.0280	.0490	.0160	.0100	.0470
MAGNESIUM	6.8000	44.0000	36.0000	35.0000	57.0000	2.6000	27.0000	25.0000
MERCURY	.0002	.0016	.0002	.0038	.0007	.0014	.0002	.0005
SELENIUM	.0020	.0100	.0620	.1300	.2000	.0230	.0040	.0040
SULFITE	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	-0.0000
SODIUM	0.0000	0.0000	0.0000	0.0000	70.0000	160.0000	150.0000	110.0000
TOTAL ELEM	266.8272	334.2066	1616.0962	1555.2118	3860.4897	1973.5604	2277.2992	2495.0665

POND B LEACHATE

WELL DESIG	LWB	LWB
DATE	760301.0000	760503.0000
REC NO.	2260.0000	2300.0000
PH	7.0000	7.9000
ALKALINITY	34.0000	120.0000
CHLORIDE	290.0000	130.0000
COD	12.0000	43.0000
COND	2600.0000	1600.0000
TDS	2400.0000	1400.0000
TSS	49.0000	530.0000
SULFATE	1200.0000	960.0000
ARSENIC	.0200	.0100
BORON	.9600	1.1000
CALCIUM	790.0000	380.0000
LEAD	.0580	.0100
MAGNESIUM	14.0000	7.7000
MERCURY	.0002	.0002
SELENIUM	.0040	.0040
SULFITE	0.0000	0.0000
SODIUM	68.0000	19.0000
TOTAL ELEM	2363.0422	1517.8242

POND B LEACHATE --- AEROSPACE ---

WELL DESIG	LWB	LWB	LWB	LWB	LWB
DATE	750211.0000	750415.0000	751103.0000	760121.0000	760503.0000
REC NO.	2400.0000	2420.0000	2440.0000	2460.0000	2480.0000
PH	5.3200	6.7300	6.1800	7.3700	7.0700
ALKALINITY	0.0000	28.0000	10.0000	2.0000	0.0000
CHLORIDE	170.0000	140.0000	1100.0000	520.0000	139.0000
COD	75.0000	0.0000	50.0000	50.0000	0.0000
COND	830.0000	300.0000	3570.0000	2700.0000	1790.0000
TDS	500.0000	320.0000	2670.0000	2540.0000	1690.0000
TSS	0.0000	0.0000	0.0000	0.0000	0.0000
SULFATE	150.0000	150.0000	675.0000	1100.0000	1000.0000
ARSENIC	.0140	.0050	.0040	.0110	0.0000
BORON	.1000	1.0000	1.0000	1.3000	3.8000
CALCIUM	20.0000	28.0000	400.0000	525.0000	450.0000
LEAD	.0400	.0200	.0100	.0100	.0100
MAGNESIUM	8.0000	8.0000	26.0000	27.0000	11.0000
MERCURY	.0010	.0004	.0002	.0007	0.0000
SELENIUM	.0170	.0080	.0160	.0090	0.0000
SULFITE	.1700	.1000	.1000	0.0000	0.0000
SODIUM	0.0000	0.0000	158.0000	83.0000	23.0000
TOTAL ELEM	348.3420	327.1334	2360.1302	2256.3307	1626.8100

POND B LEACHATE 1

WELL DESIG	LWB1	LWB1
DATE	760706.0000	760720.0000
REC NO.	2320.0000	2340.0000
PH	7.5000	7.3000
ALKALINITY	84.0000	66.0000
CHLORIDE	930.0000	130.0000
COD	64.0000	63.0000
COND	2500.0000	1800.0000
TDS	2500.0000	1900.0000
TSS	870.0000	200.0000
SULFATE	750.0000	1200.0000
ARSENIC	.0800	.0200
BORON	1.9000	2.2000
CALCIUM	630.0000	620.0000
LEAD	.0290	.0100
MAGNESIUM	27.0000	8.4000
MERCURY	.0002	.0002
SELENIUM	.0080	.0010
SULFITE	0.0000	0.0000
SODIUM	23.0000	23.0000
TOTAL ELEM	2362.0172	1983.6312

POND B LEACHATE 2

WELL DESIG	LWB2
DATE	760720.0000
REC NO.	7280.0000
PH	7.4000
ALKALINITY	92.0000
CHLORIDE	660.0000
COD	60.0000
COND	2800.0000
TDS	2800.0000
TSS	690.0000
SULFATE	970.0000
ARSENIC	.0200
BORON	2.1000
CALCIUM	800.0000
LEAD	.0180
MAGNESIUM	26.0000
MERCURY	.0005
SELENIUM	.0020
SULFITE	0.0000
SODIUM	110.0000
TOTAL ELEM	2568.1405

POND B GROUND WELL 1

WELL DESIG	GWB1	GWB1	GWB1	GWB1	GWB1	GWB1	GWB1	GWB1
DATE	750415.0000	750422.0000	750428.0000	750708.0000	750901.0000	751103.0000	760106.0000	760301.0000
REC NO.	2500.0000	2520.0000	2540.0000	2560.0000	2580.0000	2600.0000	2620.0000	2640.0000
PH	6.9000	6.9000	6.9000	6.9000	6.7000	6.9000	6.7000	6.8000
ALKALINITY	240.0000	240.0000	240.0000	240.0000	210.0000	190.0000	170.0000	170.0000
CHLORIDE	68.0000	64.0000	66.0000	82.0000	66.0000	91.0000	170.0000	140.0000
COD	0.0000	40.0000	210.0000	1400.0000	18.0000	6.0000	16.0000	9.0000
COND	610.0000	0.0000	720.0000	690.0000	660.0000	650.0000	910.0000	840.0000
TDS	420.0000	490.0000	300.0000	510.0000	530.0000	120.0000	500.0000	520.0000
TSS	120.0000	19.0000	23.0000	1000.0000	450.0000	130.0000	4200.0000	250.0000
SULFATE	24.0000	28.0000	23.0000	24.0000	42.0000	42.0000	68.0000	42.0000
ARSENIC	.0050	.0050	.0050	.0050	.0050	.0050	.0050	.0100
BORON	.1300	.1400	.1300	.1400	.7000	.2600	.2400	.0200
CALCIUM	31.0000	43.0000	0.0000	0.0000	61.0000	35.0000	100.0000	72.0000
LEAD	.1600	.0560	0.0000	0.0000	.0720	.1600	.5800	.0270
MAGNESIUM	15.0000	16.0000	0.0000	0.0000	15.0000	15.0000	27.0000	18.0000
MERCURY	.0059	.0007	.0008	.0005	.0002	.0002	.0002	.0002
SELENIUM	.0020	.0020	.0020	.0020	.0020	.0120	.0020	.0040
SULFITE	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
SODIUM	0.0000	0.0000	0.0000	0.0000	89.0000	-0.0000	95.0000	130.0000
TOTAL ELEM	138.3229	151.2037	89.1378	106.1475	273.7792	183.4572	460.8272	402.0612

POND B GROUND WELL 1

WELL DESIG	GWB1	GWB1	GWB1	GWB1
DATE	760503.0000	760712.0000	760914.0000	761109.0000
REC NO.	2660.0000	2680.0000	2700.0000	2720.0000
PH	7.1000	7.3000	7.1000	6.9000
ALKALINITY	190.0000	200.0000	200.0000	180.0000
CHLORIDE	88.0000	93.0000	150.0000	160.0000
COD	23.0000	11.0000	10.0000	18.0000
COND	740.0000	700.0000	770.0000	790.0000
TDS	450.0000	460.0000	550.0000	630.0000
TSS	2500.0000	270.0000	1100.0000	820.0000
SULFATE	120.0000	22.0000	36.0000	82.0000
ARSENIC	.0050	.0050	.0050	.0120
BORON	.1000	.8000	.1600	.1600
CALCIUM	55.0000	41.0000	45.0000	42.0000
LEAD	.1100	.3600	.0340	.0290
MAGNESIUM	14.0000	16.0000	16.0000	19.0000
MERCURY	.0002	.0003	.0002	.0013
SELENIUM	.0040	.0030	.0040	.0040
SULFITE	0.0000	0.0000	0.0000	0.0000
SODIUM	74.0000	97.0000	11.0000	140.0000
TOTAL ELEM	351.2192	270.1683	258.2532	443.2063

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POND B GROUND WELL 1--- AEROSPACE ---

WELL DESIG           GWB1         GWB1         GWB1         GWB1
DATE          750415.0000  751103.0000  760503.0000  761109.0000
REC NO.         2760.0000    2760.0000    2800.0000    8330.0000
PH                 7.6300       7.0600       7.9300       7.8200
ALKALINITY       217.0000     189.0000     173.0000     187.0000
CHLORIDE          95.0000     130.0000      88.0000     175.0000
COD               75.0000      40.0000       0.0000       0.0000
COND             620.0000     610.0000     680.0000     880.0000
TDS              400.0000     392.0000     354.0000     534.0000
TSS                0.0000       0.0000       0.0000       0.0000
SULFATE          225.0000      15.0000      60.0000      46.0000
ARSENIC             .0050        .0060        .0050        .0120
BORON               .9000        .1000        .3000       2.0000
CALCIUM           40.0000      40.0000      47.0000      39.0000
LEAD                .0300        .0200        .0200        .0350
MAGNESIUM         15.3000      15.0000      15.0000      13.5000
MERCURY             .0007        .0004        .0008        .0001
SELENIUM            .0060        .0120        .0810        .0006
SULFITE             .5200        .4000       0.0000       0.0000
SODIUM             0.0000      83.0000      79.0000     140.0000
TOTAL ELEM       377.2617     283.5384     289.4068     415.5477
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POND B GROUND WELL 2

WELL DESIG	GWB2	GWB2	GWB2	GWB2	GWB2	GWB2	GWB2	GWB2
DATE	741111.0000	741209.0000	750211.0000	750217.0000	750224.0000	750415.0000	750422.0000	750428.0000
REC NO.	2820.0000	2840.0000	2860.0000	2880.0000	2900.0000	2920.0000	2940.0000	2960.0000
PH	7.4000	6.9000	6.8000	6.7000	6.7000	6.7000	0.0000	6.7000
ALKALINITY	90.0000	58.0000	170.0000	170.0000	160.0000	160.0000	0.0000	160.0000
CHLORIDE	14.0000	86.0000	52.0000	50.0000	53.0000	52.0000	0.0000	53.0000
COD	0.0000	0.0000	15.0000	18.0000	9.0000	8.0000	14.0000	7.0000
COND	370.0000	710.0000	570.0000	570.0000	600.0000	540.0000	0.0000	530.0000
TDS	220.0000	580.0000	340.0000	330.0000	330.0000	300.0000	0.0000	310.0000
TSS	110.0000	11000.0000	0.0000	0.0000	61.0000	47.0000	0.0000	12.0000
SULFATE	47.0000	85.0000	20.0000	18.0000	14.0000	19.0000	0.0000	15.0000
ARSENIC	.0050	.0050	.0050	.0050	.0050	.0050	.0050	.0050
BORON	.1000	.4500	.4500	.1000	.1000	.4200	.1300	.1000
CALCIUM	35.0000	35.0000	34.0000	31.0000	32.0000	0.0000	29.0000	29.0000
LEAD	.1200	.0100	.0150	.1100	.0780	0.0000	.0460	.0300
MAGNESIUM	8.7000	8.9000	8.7000	9.0000	17.0000	0.0000	11.0000	11.0000
MERCURY	.0002	0.0000	.0002	.0005	.0008	.0022	.0005	.0013
SELENIUM	.0020	.0020	.0020	.0020	.0020	.0030	.0040	.0030
SULFITE	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
SODIUM	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
TOTAL ELEM	104.9272	215.3670	115.1722	108.2175	116.1858	71.4302	40.1855	108.1393

POND B GROUND WELL 2

WELL DESIG	GWB2	GWB2	GWB2	GWB2	GWB2	GWB2	GWB2
DATE	750706.0000	750901.0000	751103.0000	760106.0000	760301.0000	760503.0000	760712.0000
REC NO.	2980.0000	3000.0000	3020.0000	3040.0000	3060.0000	3080.0000	3100.0000
PH	6.9000	6.8000	7.0000	7.2000	6.9000	7.2000	7.3000
ALKALINITY	170.0000	210.0000	220.0000	270.0000	130.0000	170.0000	180.0000
CHLORIDE	120.0000	92.0000	26.0000	52.0000	51.0000	54.0000	88.0000
COD	10.0000	92.0000	8.0000	36.0000	4.0000	7.0000	13.0000
COND	710.0000	800.0000	690.0000	350.0000	480.0000	560.0000	680.0000
TDS	470.0000	540.0000	430.0000	0.0000	320.0000	360.0000	450.0000
TSS	2300.0000	460.0000	130.0000	0.0000	600.0000	740.0000	640.0000
SULFATE	34.0000	36.0000	39.0000	160.0000	30.0000	93.0000	65.0000
ARSENIC	.0050	.0070	.0050	.0050	.0050	.0050	.0050
BORON	.2500	1.1000	.2600	.1600	.1000	.0100	.9000
CALCIUM	42.0000	63.0000	47.0000	690.0000	34.0000	37.0000	35.0000
LEAD	.0100	.0140	.0500	1.4000	.0630	.0110	.8200
MAGNESIUM	16.0000	16.0000	19.0000	120.0000	14.0000	11.0000	14.0000
MERCURY	.0002	.0002	.0003	.0006	.0020	.0002	.0002
SELENIUM	.0020	.0020	.0010	.0020	.0040	.0050	.0030
SULFITE	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
SODIUM	88.0000	110.0000	83.0000	110.0000	70.0000	73.0000	100.0000
TOTAL ELEM	300.2672	318.1232	214.3163	1133.5676	199.1740	268.0312	303.7282

POND B GROUND WELL 2--- AEROSPACE ---

WELL DESIG	GWB2	GWB2	GWB2	GWB2
DATE	750211.0000	750415.0000	751103.0000	760503.0000
REC NO.	3140.0000	3160.0000	3180.0000	3200.0000
PH	7.5400	7.5600	7.2400	7.9100
ALKALINITY	171.0000	158.0000	233.0000	337.0000
CHLORIDE	80.0000	73.0000	110.0000	89.0000
COD	35.0000	15.0000	10.0000	0.0000
COND	530.0000	440.0000	610.0000	650.0000
TDS	320.0000	320.0000	408.0000	422.0000
TSS	0.0000	0.0000	0.0000	0.0000
SULFATE	18.0000	125.0000	27.0000	100.0000
ARSENIC	.0050	.0050	.0040	.0010
BORON	1.2000	.8000	.3000	.3000
CALCIUM	40.0000	12.0000	24.0000	55.0000
LEAD	.0500	.0900	.0100	.0100
MAGNESIUM	12.0000	13.6000	14.0000	15.0000
MERCURY	.0001	.0004	.0001	.0004
SELENIUM	.0090	.0070	.0140	.0900
SULFITE	.3000	.2700	.5000	0.0000
SODIUM	0.0000	0.0000	83.0000	75.0000
TOTAL ELEM	151.5641	224.7724	258.8281	334.4014

POND C SUPERNATE

WELL DESIG	PSC	PSC	PSC	PSC	PSC	PSC	PSC	PSC
DATE	750428.0000	750505.0000	750708.0000	750901.0000	751103.0000	760106.0000	760308.0000	760503.0000
REC NO.	3220.0000	3240.0000	3260.0000	3280.0000	3300.0000	3320.0000	3340.0000	3360.0000
PH	11.2000	10.3000	8.3000	8.4000	8.3000	8.0000	7.3000	8.8000
ALKALINITY	170.0000	31.0000	21.0000	30.0000	28.0000	40.0000	41.0000	54.0000
CHLORIDE	560.0000	240.0000	440.0000	500.0000	430.0000	180.0000	430.0000	680.0000
COD	20.0000	17.0000	18.0000	19.0000	18.0000	10.0000	30.0000	35.0000
COND	2400.0000	2300.0000	2700.0000	3800.0000	3400.0000	1600.0000	3600.0000	-0.0000
TDS	1600.0000	1500.0000	2100.0000	3200.0000	3000.0000	1800.0000	3800.0000	4300.0000
TSS	9.0000	31.0000	5.0000	11.0000	43.0000	82.0000	7.0000	22.0000
SULFATE	200.0000	200.0000	600.0000	1700.0000	1100.0000	890.0000	2300.0000	1600.0000
ARSENIC	.0080	.0050	.0070	.0060	.0050	.0150	.0050	.0050
BORON	.3400	.2600	1.5000	2.3000	.6700	0.0000	0.0000	1.1000
CALCIUM	590.0000	480.0000	450.0000	880.0000	600.0000	600.0000	1000.0000	560.0000
LEAD	.0160	.0360	.0100	.0190	.0100	.0250	.0100	.0100
MAGNESIUM	.2000	.4000	3.0000	5.3000	7.1000	8.4000	26.0000	18.0000
MERCURY	.0002	.0002	.0002	.0002	.0002	.0003	.0002	.0006
SELENIUM	.0030	.0020	.0020	.0060	.0020	.0040	.0140	.0310
SULFITE	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	-0.0000	0.0000
SODIUM	0.0000	0.0000	49.0000	75.0000	68.0000	29.0000	78.0000	120.0000
TOTAL ELEM	1350.5672	920.7032	1543.5192	3162.6312	2205.7072	1707.4443	3834.0292	2979.1466

POND C SUPERNATE

WELL DESIG	PSC	PSC	PSC
DATE	760706.0000	761005.0000	761109.0000
REC NO.	3380.0000	3400.0000	3420.0000
PH	7.8000	8.2000	8.0000
ALKALINITY	37.0000	66.0000	44.0000
CHLORIDE	500.0000	460.0000	220.0000
COD	13.0000	51.0000	21.0000
COND	2000.0000	3000.0000	2200.0000
TDS	2300.0000	3800.0000	2900.0000
TSS	15.0000	13.0000	6.0000
SULFATE	1100.0000	1900.0000	2000.0000
ARSENIC	.0200	.0350	.0120
BORON	23.0000	14.0000	7.4000
CALCIUM	460.0000	490.0000	690.0000
LEAD	.0100	.0100	.0100
MAGNESIUM	7.2000	25.0000	29.0000
MERCURY	.0002	.0002	.0002
SELENIUM	.0140	.0270	.0540
SULFITE	0.0000	0.0000	0.0000
SODIUM	16.0000	76.0000	38.0000
TOTAL ELEM	2106.2442	2965.0722	2984.4762

POND C SUPERNATE --- AEROSPACE ---

WELL DESIG	PSC	FSC	PSC	PSC
DATE	750428.0000	751103.0000	760503.0000	761109.0000
REC NO.	3480.0000	3500.0000	3520.0000	8620.0000
PH	11.4300	7.3200	8.2300	7.1500
ALKALINITY	173.0000	35.0000	45.0000	40.0000
CHLORIDE	610.0000	540.0000	680.0000	245.0000
COD	49.0000	25.0000	0.0000	0.0000
COND	2400.0000	3130.0000	4540.0000	2780.0000
TDS	1560.0000	2960.0000	4220.0000	2750.0000
TSS	0.0000	0.0000	0.0000	0.0000
SULFATE	175.0000	1500.0000	1500.0000	1475.0000
ARSENIC	.0050	.0060	.0280	.0180
BORON	.1000	2.4000	6.5000	7.8000
CALCIUM	340.0000	600.0000	850.0000	680.0000
LEAD	.1400	.0100	.0200	.0450
MAGNESIUM	3.7000	9.0000	22.0000	23.0000
MERCURY	.0003	.0003	.0011	.0001
SELENIUM	.0040	.0060	.1010	.0173
SULFITE	.8500	.1000	0.0000	0.0000
SODIUM	0.0000	68.0000	122.0000	48.0000
TOTAL ELEM	1129.7993	2719.5223	3180.6501	2478.8804

POND C LEACHATE

WELL DESIG	LWC	LWC	LWC	LWC	LWC	LWC	LWC	LWC
DATE	750211.0000	750428.0000	750429.0000	750505.0000	750707.0000	750901.0000	760106.0000	760301.0000
REC NO.	3540.0000	3560.0000	3580.0000	3600.0000	3620.0000	3640.0000	3660.0000	3680.0000
PH	7.1000	10.4000	11.8000	11.9000	11.4000	9.0000	7.3000	8.1000
ALKALINITY	56.0000	99.0000	600.0000	720.0000	300.0000	44.0000	58.0000	30.0000
CHLORIDE	5.0000	2400.0000	2100.0000	2100.0000	1200.0000	1100.0000	1000.0000	380.0000
COD	17.0000	140.0000	140.0000	130.0000	1300.0000	66.0000	30.0000	18.0000
COND	500.0000	7500.0000	8500.0000	8400.0000	5600.0000	5000.0000	4000.0000	3200.0000
TDS	340.0000	4700.0000	4600.0000	4100.0000	3200.0000	3300.0000	3500.0000	3000.0000
TSS	0.0000	73.0000	36.0000	30.0000	2800.0000	36000.0000	370.0000	160.0000
SULFATE	160.0000	750.0000	44.0000	23.0000	190.0000	820.0000	870.0000	1000.0000
ARSENIC	.0050	.0050	.0050	.0050	.0050	.0200	.0200	.0200
BORON	.1700	.1900	.1300	.1000	.3700	1.4000	0.0000	2.5000
CALCIUM	86.0000	2000.0000	2000.0000	1900.0000	650.0000	550.0000	790.0000	980.0000
LEAD	.0100	.0520	.1100	.1200	.2200	.0160	.1600	.0100
MAGNESIUM	15.0000	5.4000	.4000	.1000	8.3000	.2000	8.8000	12.0000
MERCURY	.0002	.0002	.0002	.0010	.0250	.0002	.0036	.0002
SELENIUM	.0020	.0110	.0110	.0100	.0080	.0020	.0030	.0120
SULFITE	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
SODIUM	0.0000	0.0000	0.0000	0.0000	150.0000	180.0000	18.0000	53.0000
TOTAL ELEM	266.1872	5155.6582	4144.6562	4023.3360	2198.9280	2651.6382	2686.9866	2427.5422

POND C LEACHATE

WELL DESIG	LWC	LWC
DATE	760517.0000	760706.0000
REC NO.	3700.0000	3720.0000
PH	8.2000	7.7000
ALKALINITY	3.0000	60.0000
CHLORIDE	810.0000	260.0000
COD	40.0000	42.0000
COND	4000.0000	2600.0000
TDS	3800.0000	2900.0000
TSS	370.0000	3900.0000
SULFATE	1200.0000	1600.0000
ARSENIC	.0200	.0350
BORON	6.4000	15.0000
CALCIUM	800.0000	730.0000
LEAD	.0100	.0300
MAGNESIUM	8.9000	13.0000
MERCURY	.0003	.0009
SELENIUM	.0140	.0160
SULFITE	-0.0000	0.0000
SODIUM	-0.0000	53.0000
TOTAL ELEM	2825.3443	2671.0819

POND C LEACHATE --- AEROSPACE ---

WELL DESIG	LWC	LWC	LWC	LWC	LWC
DATE	750211.0000	750428.0000	760121.0000	760301.0000	760503.0000
REC NO.	3760.0000	3780.0000	3800.0000	3820.0000	3840.0000
PH	7.4600	10.6100	6.8600	0.0000	7.2600
ALKALINITY	56.0000	50.0000	39.0000	0.0000	40.0000
CHLORIDE	42.0000	2562.0000	1050.0000	380.0000	580.0000
COD	20.0000	0.0000	60.0000	0.0000	0.0000
COND	430.0000	7500.0000	4160.0000	0.0000	4090.0000
TDS	260.0000	4720.0000	3540.0000	0.0000	3750.0000
TSS	0.0000	0.0000	0.0000	0.0000	0.0000
SULFATE	225.0000	75.0000	1175.0000	1550.0000	1500.0000
ARSENIC	.0050	.0050	.0210	0.0000	.0230
BORON	.1000	.1000	1.0000	0.0000	5.5000
CALCIUM	20.0000	1980.0000	575.0000	600.0000	700.0000
LEAD	.0400	.3600	.0100	0.0000	.0100
MAGNESIUM	14.0000	3.8000	9.0000	0.0000	12.0000
MERCURY	.0003	.0001	.0012	0.0000	.0005
SELENIUM	.0090	.0110	.0220	0.0000	.1730
SULFITE	0.0000	4.5000	0.0000	0.0000	0.0000
SODIUM	0.0000	0.0000	143.0000	0.0000	102.0000
TOTAL ELEM	301.1543	4625.7761	2953.0542	2530.0000	2899.7065

POND C GROUND WELL 1

WELL DESIG	GWC1	GWC1	GWC1	GWC1	GWC1	GWC1	GWC1	GWC1
DATE	740722.0000	740729.0000	740805.0000	740903.0000	741007.0000	741209.0000	750211.0000	750423.0000
REC NO.	3860.0000	3880.0000	3900.0000	3920.0000	3940.0000	3960.0000	3980.0000	4000.0000
PH	7.7000	7.4000	7.4000	7.5000	7.0000	0.0000	6.6000	7.6000
ALKALINITY	130.0000	120.0000	130.0000	96.0000	47.0000	0.0000	130.0000	82.0000
CHLORIDE	10.0000	9.0000	10.0000	7.0000	13.0000	0.0000	14.0000	11.0000
COD	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	12.0000	7.0000
COND	400.0000	460.0000	0.0000	0.0000	0.0000	0.0000	450.0000	340.0000
TDS	380.0000	330.0000	330.0000	450.0000	370.0000	0.0000	330.0000	240.0000
TSS	720.0000	81.0000	26.0000	0.0000	1000.0000	0.0000	0.0000	12.0000
SULFATE	56.0000	85.0000	67.0000	180.0000	78.0000	0.0000	55.0000	50.0000
ARSENIC	.0050	.0050	.0050	.0050	.0050	.0050	.0050	.0050
BORON	.1000	.1000	.1000	.1000	.1000	.2000	.1000	.1100
CALCIUM	29.0000	34.0000	34.0000	83.0000	38.0000	0.0000	33.0000	15.0000
LEAD	.1200	.0400	.0320	.0100	.0100	0.0000	.0150	.0200
MAGNESIUM	6.1000	5.9000	5.7000	12.0000	7.3000	0.0000	48.0000	2.7000
MERCURY	0.0000	.0290	.0003	.0002	.0002	0.0000	.0004	.0011
SELENIUM	.0020	.0020	.0020	.0020	.0020	.0020	.0020	.0020
SULFITE	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
SODIUM	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
TOTAL ELEM	101.3270	134.0760	116.8393	282.1172	136.4172	.2070	150.1224	78.8381

POND C GROUND WELL 1

WELL DESIG	GWC1	GWC1	GWC1	GWC1	GWC1	GWC1	GWC1	GWC1
DATE	750428.0000	750505.0000	750708.0000	750901.0000	751103.0000	760301.0000	760503.0000	760712.0000
REC NO.	4020.0000	4040.0000	4060.0000	4080.0000	4100.0000	4120.0000	4140.0000	4160.0000
PH	7.6000	6.7000	7.0000	6.9000	7.0000	6.5000	7.1000	6.9000
ALKALINITY	88.0000	110.0000	120.0000	80.0000	76.0000	80.0000	100.0000	76.0000
CHLORIDE	11.0000	12.0000	40.0000	13.0000	15.0000	24.0000	13.0000	14.0000
COD	5.0000	5.0000	5.0000	8.0000	7.0000	5.0000	15.0000	5.0000
COND	530.0000	450.0000	440.0000	470.0000	420.0000	360.0000	530.0000	360.0000
TDS	300.0000	420.0000	650.0000	550.0000	400.0000	330.0000	430.0000	320.0000
TSS	13.0000	28.0000	3000.0000	1200.0000	550.0000	1600.0000	160.0000	75.0000
SULFATE	430.0000	18.0000	180.0000	160.0000	83.0000	83.0000	190.0000	64.0000
ARSENIC	.0050	.0050	.0050	.0200	.0050	.0100	.0100	.0050
BORON	.1000	.1000	.1000	.7000	.2400	.1200	.1200	.0700
CALCIUM	19.0000	22.0000	40.0000	48.0000	33.0000	230.0000	47.0000	18.0000
LEAD	.0220	.0220	.1500	.0630	.1500	.5200	.2400	.4100
MAGNESIUM	3.1000	4.6000	9.3000	7.4000	7.1000	32.0000	3.9000	3.4000
MERCURY	.0002	.0052	.0009	.0006	.0002	.0002	.0002	.0002
SELENIUM	.0020	.0050	.0020	.0020	.0010	.0040	.0070	.0010
SULFITE	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0300
SODIUM	0.0000	0.0000	53.0000	54.0000	53.0000	62.0000	46.0000	54.0000
TOTAL ELEM	463.2292	56.7372	322.5579	283.1856	196.4962	431.6542	300.2772	153.8862

POND C GROUND WELL 1--- AEROSPACE ---

WELL DESIG	GWC1	GWC1	GWC1	GWC1
DATE	740904.0000	750428.0000	751103.0000	760503.0000
REC NO.	4200.0000	4220.0000	4240.0000	4260.0000
PH	8.0800	7.3700	7.0800	8.0100
ALKALINITY	106.0000	93.0000	76.0000	228.0000
CHLORIDE	61.0000	55.0000	64.0000	110.0000
COD	7.0000	48.0000	10.0000	0.0000
COND	590.0000	330.0000	310.0000	1950.0000
TDS	460.0000	280.0000	340.0000	2050.0000
TSS	0.0000	0.0000	0.0000	0.0000
SULFATE	250.0000	75.0000	70.0000	1100.0000
ARSENIC	.0050	.0050	.0020	.0870
BORON	.1000	.1000	.5000	.5000
CALCIUM	480.0000	12.0000	16.0000	400.0000
LEAD	.0500	.0200	.0200	.0200
MAGNESIUM	18.0000	4.1000	5.0000	5.0000
MERCURY	.0007	.0003	.0001	.0008
SELENIUM	.0040	.0120	.0180	.0950
SULFITE	.2000	.1900	.2000	0.0000
SODIUM	0.0000	0.0000	57.0000	60.0000
TOTAL ELEM	809.3597	146.4273	212.7401	1675.7028

POND C GROUND WELL 2

WELL DESIG	GWC2	GWC2	GWC2	GWC2	GWC2	GWC2	GWC2	GWC2
DATE	740305.0000	740903.0000	741007.0000	741209.0000	750211.0000	750423.0000	750428.0000	750505.0000
REC NO.	4280.0000	4300.0000	4320.0000	4340.0000	4360.0000	4380.0000	4400.0000	4420.0000
PH	7.3000	7.3000	7.3000	0.0000	7.2000	7.2000	7.2000	7.1000
ALKALINITY	68.0000	80.0000	99.0000	0.0000	140.0000	150.0000	150.0000	160.0000
CHLORIDE	14.0000	15.0000	26.0000	0.0000	63.0000	65.0000	66.0000	100.0000
COD	0.0000	0.0000	0.0000	0.0000	13.0000	9.0000	9.0000	18.0000
COND	0.0000	0.0000	0.0000	0.0000	610.0000	540.0000	570.0000	650.0000
TDS	230.0000	170.0000	260.0000	0.0000	320.0000	320.0000	330.0000	400.0000
TSS	210.0000	0.0000	120.0000	0.0000	0.0000	48.0000	20.0000	87.0000
SULFATE	48.0000	30.0000	30.0000	0.0000	22.0000	17.0000	23.0000	52.0000
ARSENIC	.0050	.0050	.0050	.0050	.0050	.0050	.0050	.0050
BORON	.1000	.1000	.1000	.1000	.1000	.1700	.2000	.2500
CALCIUM	31.0000	23.0000	26.0000	0.0000	38.0000	36.0000	36.0000	44.0000
LEAD	.0240	0.0000	.0100	0.0000	.0440	.0220	.0200	.0580
MAGNESIUM	8.6000	8.4000	8.4000	0.0000	9.4000	12.0000	15.0000	13.0000
MERCURY	.0002	.0002	.0002	0.0000	.0002	.0003	.0008	.0028
SELENIUM	.0020	.0020	.0020	.0020	.0020	.0020	.0020	.0020
SULFITE	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
SODIUM	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
TOTAL ELEM	101.7312	76.5072	90.5172	.1070	132.5512	150.1993	140.2278	209.3178

POND C GROUND WELL 2

WELL DESIG	GWC2	GWC2	GWC2	GWC2	GWC2	GWC2
DATE	750708.0000	750901.0000	751103.0000	760315.0000	760503.0000	760712.0000
REC NO.	4460.0000	4480.0000	4440.0000	4500.0000	4520.0000	4540.0000
PH	7.0000	7.2000	7.3000	7.0000	8.0000	7.5000
ALKALINITY	130.0000	120.0000	100.0000	130.0000	150.0000	130.0000
CHLORIDE	110.0000	110.0000	130.0000	0.0000	25.0000	37.0000
COD	12.0000	10.0000	23.0000	5.0000	25.0000	5.0000
COND	850.0000	910.0000	980.0000	380.0000	680.0000	410.0000
TDS	540.0000	840.0000	650.0000	230.0000	500.0000	270.0000
TSS	3800.0000	2500.0000	4300.0000	850.0000	540.0000	270.0000
SULFATE	110.0000	170.0000	200.0000	26.0000	240.0000	41.0000
ARSENIC	.0050	.0050	.0050	.0100	.0100	.0050
BORON	2.5000	2.4000	.6100	.5900	.6500	.3600
CALCIUM	0.0000	120.0000	290.0000	28.0000	98.0000	37.0000
LEAD	0.0000	.1000	.3000	.4800	.0280	.3200
MAGNESIUM	0.0000	34.0000	84.0000	22.0000	13.0000	15.0000
MERCURY	.0009	.0002	.0002	.0002	.0004	.0002
SELENIUM	.0020	.0020	.0010	.0030	.0040	.0010
SULFITE	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
SODIUM	0.0000	52.0000	59.0000	26.0000	23.0000	28.0000
TOTAL ELEM	222.5079	488.5072	763.9162	103.0832	399.6924	158.6862

POND C GROUND WELL 2--- AEROSPACE ---

WELL DESIG	GWC2	GWC2	GWC2	GWC2	GWC2
DATE	740904.0000	750428.0000	751103.0000	760315.0000	760503.0000
REC NO.	4580.0000	4600.0000	4620.0000	4640.0000	4660.0000
PH	7.8800	7.3500	7.2000	0.0000	7.8100
ALKALINITY	83.0000	149.0000	101.0000	0.0000	141.0000
CHLORIDE	41.0000	99.0000	195.0000	42.0000	54.0000
COD	0.0000	75.0000	10.0000	0.0000	0.0000
COND	290.0000	530.0000	950.0000	0.0000	550.0000
TDS	154.0000	340.0000	672.0000	0.0000	406.0000
TSS	0.0000	0.0000	0.0000	0.0000	0.0000
SULFATE	37.0000	25.0000	150.0000	0.0000	110.0000
ARSENIC	.0050	.0050	.0040	0.0000	.0010
BORON	.4000	.1000	3.3000	0.0000	.5000
CALCIUM	36.0000	32.0000	48.0000	28.0000	78.0000
LEAD	.0300	.0500	.0200	0.0000	.0100
MAGNESIUM	13.0000	13.4000	40.0000	0.0000	15.0000
MERCURY	.0006	.0003	.0002	0.0000	.0006
SELENIUM	.0050	.0100	.0040	0.0000	.0520
SULFITE	.1000	.2800	.2000	0.0000	0.0000
SODIUM	0.0000	0.0000	58.0000	0.0000	26.0000
TOTAL ELEM	127.5406	169.8453	494.5282	70.0000	283.5636

POND D SUPERNATE

WELL DESIG	PSD	PSD	PSD	PSD	PSD	PSD	PSD	PSD
DATE	741028.0000	741209.0000	750211.0000	750217.0000	750224.0000	750428.0000	750708.0000	750901.0000
REC NO.	4680.0000	4700.0000	4720.0000	4740.0000	4760.0000	4780.0000	4800.0000	4820.0000
PH	8.9000	9.2000	8.5000	8.3000	8.1000	8.0000	8.4000	8.0000
ALKALINITY	270.0000	310.0000	97.0000	120.0000	170.0000	35.0000	40.0000	38.0000
CHLORIDE	2400.0000	1000.0000	950.0000	1100.0000	670.0000	260.0000	200.0000	200.0000
COD	0.0000	170.0000	11.0000	19.0000	14.0000	16.0000	31.0000	39.0000
COND	9000.0000	5200.0000	4000.0000	5600.0000	3700.0000	1900.0000	2700.0000	3300.0000
TDS	7300.0000	4400.0000	3400.0000	4400.0000	3000.0000	1700.0000	2900.0000	3500.0000
TSS	98.0000	1700.0000	2900.0000	0.0000	90.0000	8.0000	7.0000	11.0000
SULFATE	1700.0000	980.0000	1100.0000	2000.0000	950.0000	750.0000	130.0000	2600.0000
ARSENIC	.1800	.0200	.2400	.3000	.1200	.0050	.0350	.4700
BORON	110.0000	42.0000	49.0000	64.0000	35.0000	11.0000	10.0000	16.0000
CALCIUM	1500.0000	1100.0000	830.0000	1000.0000	970.0000	360.0000	850.0000	1200.0000
LEAD	.0100	.0100	.0270	.0100	.0120	.0100	.0100	.0230
MAGNESIUM	190.0000	40.0000	170.0000	200.0000	180.0000	34.0000	17.0000	22.0000
MERCURY	.0002	.0002	.0002	.0002	.0002	.0002	.0016	.0002
SELENIUM	.0400	.0280	.0750	.0800	.0600	.0180	.0020	.0020
SULFITE	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
SODIUM	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	13.0000	20.0000
TOTAL ELEM	5900.2302	3162.0582	3099.3422	4364.3902	2805.1922	1415.0332	1220.0486	4058.4952

POND D SUPERNATE

WELL DESIG	PSD	PSD	PSD	PSD	PSD	PSD	PSD
DATE	751103.0000	760106.0000	760301.0000	760503.0000	760706.0000	760909.0000	761109.0000
REC NO.	4840.0000	4860.0000	4880.0000	4900.0000	4920.0000	4940.0000	4960.0000
PH	8.3000	7.6000	7.3000	7.8000	7.4000	7.4000	7.1000
ALKALINITY	33.0000	30.0000	24.0000	36.0000	42.0000	860.0000	30.0000
CHLORIDE	90.0000	32.0000	23.0000	23.0000	50.0000	14.0000	90.0000
COD	36.0000	5.0000	0.0000	35.0000	25.0000	45.0000	17.0000
COND	2500.0000	1000.0000	1000.0000	1600.0000	1100.0000	1800.0000	1900.0000
TDS	2600.0000	1000.0000	960.0000	1600.0000	1200.0000	680.0000	2700.0000
TSS	14.0000	18.0000	2.0000	74.0000	4.0000	9200.0000	8.0000
SULFATE	1200.0000	660.0000	650.0000	850.0000	1300.0000	2000.0000	2100.0000
ARSENIC	.5800	.0050	.0250	.0100	.0480	.1800	.0140
BORON	11.0000	0.0000	1.0000	1.0000	.7000	1.7000	2.6000
CALCIUM	710.0000	360.0000	340.0000	320.0000	320.0000	470.0000	580.0000
LEAD	.0100	.0100	.0100	.0100	.0100	.0910	.0100
MAGNESIUM	36.0000	14.0000	14.0000	14.0000	8.9000	32.0000	41.0000
MERCURY	.0002	.0002	.0006	.0002	.0002	.0002	.0006
SELENIUM	.0010	.0020	.0040	.0040	.0010	.0020	.0030
SULFITE	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
SODIUM	22.0000	7.0000	7.5000	12.0000	0.0000	13.0000	19.0000
TOTAL ELEM	2069.5912	1073.0172	1035.5396	1220.0242	1679.6592	2530.9732	2832.6276

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POND D SUPERNATE     --- AEROSPACE ---


WELL DESIG         PSD          PSD          PSD          PSD          PSD          PSD
DATE       741028.0000  750211.0000  750707.0000  751103.0000  760503.0000  761109.0000
REC NO.      5020.0000    5040.0000    5060.0000    5080.0000    5100.0000    8800.0000
PH              8.7000       8.2700       7.4800       7.2800       6.9200       7.2300
ALKALINITY      0.0000      68.0000      45.0000      41.0000      35.0000      46.0000
CHLORIDE     3000.0000    1100.0000     205.0000     225.0000      84.0000     135.0000
COD             0.0000       0.0000      95.0000      40.0000       0.0000       0.0000
COND         5600.0000    3600.0000    2440.0000    2380.0000    1580.0000    2330.0000
TDS          6340.0000    3020.0000    3320.0000    2530.0000    1620.0000    2514.0000
TSS            30.0000       0.0000       0.0000       0.0000       0.0000       0.0000
SULFATE      1550.0000     950.0000    1700.0000    1625.0000    1000.0000    1475.0000
ARSENIC          .0050        .2800        .0900        .0040        .0340        .0160
BORON          98.0000      44.0000       8.0000       7.8000       1.5000       4.0000
CALCIUM      1640.0000     560.0000     460.0000     600.0000     400.0000     650.0000
LEAD             .0400        .2100        .0500        .0100        .0100        .0350
MAGNESIUM        .6000     152.0000      15.5000      37.0000      19.0000      30.0000
MERCURY         0.0000       0.0000       0.0000        .0002        .0013        .0001
SELENIUM         .0409        .0620        .0020        .0020        .0170        .0006
SULFITE         2.8000       1.5000        .3600        .1000       0.0000       0.0000
SODIUM          0.0000       0.0000       0.0000      26.0000     120.0000      22.0000
TOTAL ELEM   6291.4859    2808.0520    2389.0020    2520.9162    1624.5623    2316.0517
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POND D LEACHATE

WELL DESIG	LWD	LWD	LWD	LWD	LWD	LWD	LWD	LWD
DATE	741028.0000	741209.0000	750211.0000	750217.0000	750228.0000	750428.0000	750707.0000	750901.0000
REC NO.	5120.0000	5140.0000	5160.0000	5180.0000	5200.0000	5220.0000	5240.0000	5260.0000
PH	7.6000	8.8000	9.0000	9.1000	9.0000	8.7000	8.3000	7.7000
ALKALINITY	40.0000	200.0000	160.0000	140.0000	120.0000	120.0000	110.0000	54.0000
CHLORIDE	210.0000	6900.0000	1400.0000	310.0000	560.0000	1500.0000	810.0000	680.0000
COD	0.0000	60.0000	13.0000	15.0000	0.0000	27.0000	20.0000	21.0000
COND	1700.0000	6500.0000	5000.0000	4300.0000	3200.0000	4400.0000	4600.0000	4200.0000
TDS	1300.0000	5200.0000	4200.0000	3700.0000	3500.0000	4000.0000	4500.0000	4000.0000
TSS	180.0000	220.0000	0.0000	0.0000	34.0000	20.0000	1400.0000	100.0000
SULFATE	590.0000	580.0000	1200.0000	0.0000	1200.0000	1600.0000	1100.0000	1700.0000
ARSENIC	[illegible]	.0280	.0880	.1100	.0700	.1600	.0080	1.0000
BORON	4.4000	[illegible]	58.0000	48.0000	39.0000	47.0000	55.0000	54.0000
CALCIUM	240.0000	[illegible]	1200.0000	990.0000	1200.0000	1100.0000	940.0000	1200.0000
LEAD	.0100	.0100	.0150	.0370	.0280	.0300	.1800	.0210
MAGNESIUM	29.0000	6.0000	66.0000	58.0000	84.0000	140.0000	180.0000	170.0000
MERCURY	.0002	.0002	.0007	.0035	.0013	.0008	.0075	.0002
SELENIUM	.0020	.0480	.0020	.1000	.0160	.0080	.0480	.0140
SULFITE	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
SODIUM	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	38.0000	30.0000
TOTAL ELEM	1073.4172	9145.0782	3924.1057	1406.2505	3083.1153	4387.1988	3123.2435	3835.0352

POND D LEACHATE

WELL DESIG	LWD	LWD	LWD	LWD	LWD	LWD	LWD
DATE	751103.0000	760106.0000	760301.0000	760503.0000	760706.0000	760909.0000	761109.0000
REC NO.	5280.0000	5300.0000	5340.0000	5320.0000	5360.0000	5380.0000	7400.0000
PH	6.9000	9.0000	8.8000	7.6000	7.4000	6.0000	4.6000
ALKALINITY	31.0000	68.0000	48.0000	28.0000	54.0000	11.0000	1.0000
CHLORIDE	450.0000	260.0000	56.0000	180.0000	190.0000	100.0000	100.0000
COD	36.0000	180.0000	82.0000	40.0000	54.0000	32.0000	46.0000
COND	3500.0000	2600.0000	2500.0000	2500.0000	2400.0000	2100.0000	2000.0000
TDS	3400.0000	2800.0000	2600.0000	2600.0000	3000.0000	2600.0000	2700.0000
TSS	120.0000	220.0000	23.0000	7.0000	2400.0000	4200.0000	10.0000
SULFATE	1200.0000	1200.0000	1100.0000	1200.0000	1500.0000	2100.0000	2300.0000
ARSENIC	.0400	.1700	.4800	.1200	.4800	.1700	.4500
BORON	31.0000	16.0000	9.5000	8.3000	13.0000	7.4000	8.0000
CALCIUM	940.0000	1000.0000	1000.0000	470.0000	640.0000	350.0000	640.0000
LEAD	.0100	.0700	.0750	.0100	.0210	.0220	.0100
MAGNESIUM	79.0000	26.0000	18.0000	14.0000	29.0000	20.0000	22.0000
MERCURY	.0002	.0004	.0002	.0002	.0008	.0002	.0002
SELENIUM	.0060	.0040	.0040	.0080	.0320	.0020	.0130
SULFITE	0.0000	0.0000	0.0000	-0.0000	0.0000	0.0000	0.0000
SODIUM	14.0000	8.7000	11.0000	17.0000	22.0000	85.0000	10.0000
TOTAL ELEM	2714.0562	2510.9444	2195.0592	1839.4382	2394.5338	2662.5942	3080.4732

POND D LEACHATE --- AEROSPACE ---

WELL DESIG	LWD	LWD	LWD	LWD	LWD	LWD	LWD
DATE	741028.0000	750211.0000	750707.0000	751103.0000	760121.0000	760503.0000	761109.0000
REC NO.	5420.0000	5440.0000	5460.0000	5480.0000	5500.0000	5520.0000	8680.0000
PH	7.6200	8.9600	8.0800	4.5900	7.7900	5.6500	2.6000
ALKALINITY	0.0000	53.0000	130.0000	0.0000	1.0000	3.0000	0.0000
CHLORIDE	285.0000	1300.0000	940.0000	490.0000	970.0000	240.0000	170.0000
COD	75.0000	0.0000	95.0000	25.0000	50.0000	0.0000	0.0000
COND	1600.0000	5000.0000	4270.0000	570.0000	2740.0000	2380.0000	2670.0000
TDS	1210.0000	3960.0000	4240.0000	3370.0000	2970.0000	2560.0000	2436.0000
TSS	790.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
SULFATE	425.0000	1425.0000	1600.0000	1750.0000	1375.0000	1400.0000	1450.0000
ARSENIC	.0040	.0300	.2100	.0120	.3400	.9050	.3200
BORON	7.8000	52.0000	58.0000	32.0000	1.3000	6.5000	8.8000
CALCIUM	150.0000	960.0000	900.0000	760.0000	675.0000	600.0000	650.0000
LEAD	.0130	.2600	.0500	.0100	.0100	.0100	.0250
MAGNESIUM	8.1000	63.0000	18.0000	99.0000	37.0000	18.0000	14.0000
MERCURY	0.0000	0.0000	.0002	.0005	.0012	.0013	.0001
SELENIUM	.0066	.0160	.0550	.0060	.0040	.0650	.0047
SULFITE	1.3000	6.1000	.4000	1.0000	0.0000	0.0000	0.0000
SODIUM	0.0000	0.0000	0.0000	14.0000	17.0000	17.0000	10.0000
TOTAL ELEM	877.2236	3806.4060	3516.7152	3146.0265	3075.6552	2282.4813	2303.1498

POND D GROUND WELL 1

WELL DESIG	GWD1	GWD1	GWD1	GWD1	GWD1	GWD1	GWD1	GWD1
DATE	740722.0000	740729.0000	740805.0000	740903.0000	741007.0000	741028.0000	741104.0000	741111.0000
REC NO.	5540.0000	5560.0000	5580.0000	5600.0000	5620.0000	5640.0000	5660.0000	5680.0000
PH	7.1000	6.8000	6.7000	7.0000	6.8000	6.9000	7.3000	7.8000
ALKALINITY	72.0000	110.0000	140.0000	140.0000	60.0000	52.0000	100.0000	52.0000
CHLORIDE	20.0000	50.0000	72.0000	110.0000	89.0000	170.0000	17.0000	12.0000
COD	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
COND	220.0000	420.0000	0.0000	0.0000	0.0000	670.0000	670.0000	600.0000
TDS	210.0000	260.0000	330.0000	410.0000	330.0000	420.0000	510.0000	0.0000
TSS	2100.0000	100.0000	15.0000	0.0000	64.0000	6600.0000	2200.0000	0.0000
SULFATE	16.0000	22.0000	14.0000	12.0000	40.0000	85.0000	160.0000	340.0000
ARSENIC	.0150	.0080	.0060	.0050	.0050	.0050	.0050	.0050
BORON	0.0000	.1000	.1000	.1000	.1000	.1000	.2500	.1000
CALCIUM	0.0000	27.0000	30.0000	29.0000	18.0000	17.0000	0.0000	0.0000
LEAD	0.0000	.0790	.0490	0.0000	.0100	.0100	0.0000	0.0000
MAGNESIUM	0.0000	11.0000	11.0000	13.0000	6.8000	7.3000	0.0000	0.0000
MERCURY	.0002	.0010	.0002	.0002	.0002	.0002	0.0000	0.0000
SELENIUM	.0020	.0020	.0020	.0020	.0020	.0020	.0020	.0020
SULFITE	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
SODIUM	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
TOTAL ELEM	36.0172	110.1900	127.1572	164.1072	153.9172	279.4172	177.2570	352.1070

POND D GROUND WELL 1

WELL DESIG	GWD1	GWD1	GWD1	GWD1	GWD1	GWD1	GWD1	GWD1
DATE	741209.0000	750211.0000	750217.0000	750224.0000	750428.0000	750708.0000	750901.0000	751103.0000
REC NO.	5700.0000	5720.0000	5740.0000	5760.0000	5780.0000	5800.0000	5820.0000	5840.0000
PH	0.0000	6.9000	6.7000	6.7000	6.9000	6.9000	7.0000	7.1000
ALKALINITY	0.0000	140.0000	150.0000	140.0000	150.0000	140.0000	140.0000	54.0000
CHLORIDE	0.0000	150.0000	100.0000	100.0000	240.0000	160.0000	320.0000	320.0000
COD	0.0000	14.0000	24.0000	16.0000	14.0000	22.0000	13.0000	0.0000
COND	0.0000	700.0000	660.0000	680.0000	690.0000	890.0000	1400.0000	1200.0000
TDS	0.0000	420.0000	380.0000	380.0000	410.0000	740.0000	870.0000	800.0000
TSS	0.0000	0.0000	0.0000	190.0000	12.0000	720.0000	340.0000	170.0000
SULFATE	0.0000	24.0000	7.0000	9.0000	38.0000	74.0000	320.0000	130.0000
ARSENIC	.0050	.0050	.0050	.0050	.0050	.0050	.0050	.0050
BORON	.1000	200.0000	.1000	.1300	.1600	.2200	.6000	.2400
CALCIUM	0.0000	66.0000	38.0000	37.0000	0.0000	53.0000	99.0000	160.0000
LEAD	0.0000	.0160	.0320	.0900	0.0000	.2600	.0190	.3400
MAGNESIUM	0.0000	9.1000	8.9000	16.0000	0.0000	22.0000	29.0000	61.0000
MERCURY	0.0000	.0002	.0002	.0020	.0005	.0011	.0002	.0002
SELENIUM	.0020	.0020	.0020	.0020	.0020	.0020	.0020	.0010
SULFITE	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
SODIUM	0.0000	0.0000	0.0000	0.0000	0.0000	110.0000	120.0000	160.0000
TOTAL ELEM	.1070	449.1232	154.0392	162.2290	278.1675	419.4881	888.6262	831.5862

POND D GROUND WELL 1

WELL DESIG	GWD1	GWD1	GWD1	GWD1
DATE	760315.0000	760503.0000	760712.0000	760914.0000
REC NO.	5860.0000	5880.0000	5900.0000	5920.0000
PH	6.5000	7.1000	7.3000	6.7000
ALKALINITY	61.0000	86.0000	110.0000	82.0000
CHLORIDE	0.0000	240.0000	350.0000	450.0000
COD	13.0000	27.0000	34.0000	42.0000
COND	1300.0000	1100.0000	1300.0000	1500.0000
TDS	810.0000	650.0000	830.0000	1100.0000
TSS	490.0000	400.0000	140.0000	1300.0000
SULFATE	20.0000	40.0000	40.0000	110.0000
ARSENIC	.0100	.0050	.0050	.0050
BORON	.0700	.1300	.1700	.1900
CALCIUM	160.0000	40.0000	82.0000	77.0000
LEAD	.3400	.0120	4.0000	.1600
MAGNESIUM	29.0000	15.0000	27.0000	33.0000
MERCURY	.0002	.0002	.0002	.0002
SELENIUM	.0020	.0040	.0020	.0010
SULFITE	0.0000	0.0000	0.0000	0.0000
SODIUM	190.0000	140.0000	180.0000	18.0000
TOTAL ELEM	399.4222	475.1512	683.1772	688.3562

POND D GROUND WELL 1--- AEROSPACE ---

WELL DESIG	GWD1	GWD1	GWD1	GWD1	GWD1
DATE	741007.0000	741028.0000	750211.0000	751103.0000	760503.0000
REC NO.	5960.0000	5980.0000	6000.0000	6020.0000	6040.0000
PH	7.7000	7.4800	7.4900	7.0100	7.2700
ALKALINITY	76.0000	0.0000	138.0000	60.0000	86.0000
CHLORIDE	170.0000	210.0000	135.0000	440.0000	500.0000
COD	25.0000	0.0000	40.0000	25.0000	0.0000
COND	380.0000	660.0000	640.0000	1.1000	1.1000
TDS	696.0000	324.0000	372.0000	690.0000	642.0000
TSS	0.0000	1010.0000	0.0000	0.0000	0.0000
SULFATE	29.0000	29.0000	10.0000	15.0000	18.0000
ARSENIC	.0040	.0040	.0050	.0060	.0130
BORON	.1000	.2000	1.0000	.9000	.5000
CALCIUM	10.0000	20.0000	28.0000	32.0000	56.0000
LEAD	.0500	.0130	.0400	.0100	.0100
MAGNESIUM	7.4000	11.2000	17.0000	25.0000	26.0000
MERCURY	.0010	.0013	.0003	.0003	.0006
SELENIUM	.0020	.0030	.0050	.0040	.0520
SULFITE	28.0000	.1000	.6000	.1000	0.0000
SODIUM	0.0000	0.0000	0.0000	149.0000	148.0000
TOTAL ELEM	244.5570	270.5263	191.6503	662.0203	748.5756

POND E SUPERNATE

WELL DESIG	PSE	PSE	PSE	PSE	PSE	PSE	PSE	PSE
DATE	750211.0000	750428.0000	750708.0000	750901.0000	751103.0000	760106.0000	760301.0000	760505.0000
REC NO.	6060.0000	6080.0000	6100.0000	6120.0000	6140.0000	6160.0000	6180.0000	6200.0000
PH	11.9000	10.2000	7.5000	7.9000	7.9000	7.6000	8.0000	7.6000
ALKALINITY	410.0000	34.0000	27.0000	26.0000	27.0000	32.0000	22.0000	32.0000
CHLORIDE	170.0000	110.0000	100.0000	88.0000	110.0000	40.0000	68.0000	42.0000
COD	6.0000	9.0000	7.0000	15.0000	14.0000	8.0000	14.0000	27.0000
COND	2800.0000	1600.0000	2000.0000	2500.0000	2600.0000	1200.0000	2300.0000	2400.0000
TDS	1300.0000	1200.0000	1700.0000	2200.0000	2400.0000	1200.0000	2200.0000	2300.0000
TSS	6.0000	12.0000	19.0000	46.0000	120.0000	26.0000	5.0000	7.0000
SULFATE	220.0000	390.0000	840.0000	1400.0000	1100.0000	850.0000	1100.0000	1400.0000
ARSENIC	.0050	.0050	.0100	.0100	.0050	.0050	.0050	.0050
BORON	.1100	.3300	.6600	.8000	.2500	0.0000	.2200	.2900
CALCIUM	19.0000	170.0000	260.0000	400.0000	360.0000	400.0000	500.0000	410.0000
LEAD	.0100	.0360	.0110	.0170	.1000	.0100	.0100	.0100
MAGNESIUM	.3000	1.0000	3.7000	3.3000	4.1000	4.5000	2.1000	5.8000
MERCURY	.0008	.0002	.0002	.0002	.0002	.0002	.0002	.0002
SELENIUM	.0020	.0030	.0020	.0020	.0010	.0040	.0040	.0020
SULFITE	0.0000	0.0000	0.0000	0.0000	0.0000	-0.0000	-0.0000	0.0000
SODIUM	0.0000	0.0000	140.0000	180.0000	190.0000	56.0000	170.0000	110.0000
TOTAL ELEM	409.4278	671.3742	1344.3832	2072.1292	1764.4562	1350.5192	1840.3392	1968.1072

POND E SUPERNATE

WELL DESIG	PSE	PSE	PSE
DATE	760706.0000	760914.0000	761109.0000
REC NO.	6220.0000	6240.0000	6260.0000
PH	7.3000	8.0000	8.7000
ALKALINITY	36.0000	39.0000	22.0000
CHLORIDE	22.0000	43.0000	90.0000
COD	13.0000	33.0000	14.0000
COND	1300.0000	2200.0000	2000.0000
TDS	1300.0000	2700.0000	2400.0000
TSS	14.0000	82.0000	6.0000
SULFATE	770.0000	2200.0000	1500.0000
ARSENIC	.0050	.0050	.0020
BORON	.5900	1.2000	.6900
CALCIUM	300.0000	530.0000	660.0000
LEAD	.0410	.0320	.0100
MAGNESIUM	3.0000	4.9000	6.8000
MERCURY	.0002	.0004	.0002
SELENIUM	.0010	.0010	.0030
SULFITE	0.0000	0.0000	0.0000
SODIUM	38.0000	59.0000	110.0000
TOTAL ELEM	1133.6372	2838.1384	2367.5052

POND E SUPERNATE --- AEROSPACE ---

WELL DESIG	PSE	PSE	PSE	PSE	PSE
DATE	750211.0000	750707.0000	751103.0000	760503.0000	761109.0000
REC NO.	6320.0000	6340.0000	6360.0000	6380.0000	8860.0000
PH	11.7900	6.9500	7.2100	6.8600	7.1100
ALKALINITY	536.0000	28.0000	74.0000	32.0000	20.0000
CHLORIDE	365.0000	245.0000	170.0000	110.0000	175.0000
COD	20.0000	80.0000	10.0000	0.0000	0.0000
COND	2900.0000	1660.0000	2380.0000	2270.0000	2370.0000
TDS	1440.0000	1720.0000	2380.0000	2310.0000	2364.0000
TSS	0.0000	0.0000	0.0000	0.0000	0.0000
SULFATE	250.0000	1000.0000	1375.0000	1400.0000	1425.0000
ARSENIC	.0040	.0040	.0060	.0230	.0160
BORON	.4000	.7000	.8000	1.5000	2.0000
CALCIUM	24.0000	260.0000	80.0000	450.0000	500.0000
LEAD	.0500	.0500	.0200	.0100	.0350
MAGNESIUM	30.0000	3.3000	5.0000	7.0000	5.0000
MERCURY	0.0000	.0001	.0002	.0007	.0001
SELENIUM	.0013	.0190	.0160	.0430	.0006
SULFITE	.2800	.1800	.4000	0.0000	0.0000
SODIUM	0.0000	190.0000	195.0000	114.0000	102.0000
TOTAL ELEM	669.7353	1699.2531	1826.2422	2082.5767	2209.0517

POND E LEACHATE

WELL DESIG	LWE	LWE	LWE	LWE	LWE	LWE	LWE	LWE
DATE	750211.0000	750428.0000	750707.0000	750901.0000	751103.0000	760106.0000	760301.0000	760503.0000
REC NO.	6400.0000	6420.0000	6440.0000	6460.0000	6480.0000	7220.0000	7240.0000	7260.0000
PH	7.9000	11.1000	11.2000	10.7000	10.5000	9.5000	9.9000	8.2000
ALKALINITY	120.0000	490.0000	700.0000	550.0000	380.0000	190.0000	110.0000	110.0000
CHLORIDE	1000.0000	0.0000	650.0000	25.0000	320.0000	370.0000	490.0000	420.0000
COD	56.0000	320.0000	180.0000	150.0000	240.0000	110.0000	0.0000	110.0000
COND	4000.0000	0.0000	4600.0000	4000.0000	3700.0000	3300.0000	3700.0000	3800.0000
TDS	2400.0000	3400.0000	2900.0000	2700.0000	2700.0000	2700.0000	2800.0000	2400.0000
TSS	0.0000	14.0000	9300.0000	7600.0000	14.0000	980.0000	92.0000	1200.0000
SULFATE	300.0000	670.0000	370.0000	1100.0000	850.0000	1300.0000	1100.0000	100.0000
ARSENIC	.0270	.1400	.1100	.0550	.0960	.0550	.0650	0.0000
BORON	.6800	.1400	.1000	.8000	.3500	3.0000	.3000	.0500
CALCIUM	98.0000	13.0000	83.0000	83.0000	14.0000	49.0000	28.0000	0.0000
LEAD	.0480	.0200	.0550	.1400	.0100	.6100	.0620	0.0000
MAGNESIUM	5.1000	.5000	23.0000	13.0000	.2000	3.5000	.9000	0.0000
MERCURY	.0005	.0013	.0033	.0012	.0008	.0047	.0014	.0028
SELENIUM	.0020	.0460	.0020	.0170	.0060	.0080	.0100	.0040
SULFITE	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
SODIUM	0.0000	0.0000	750.0000	610.0000	630.0000	0.0000	0.0000	0.0000
TOTAL ELEM	1403.8575	683.8473	1876.2703	1832.0132	1814.6628	1726.1777	1619.3364	520.0568

POND E LEACHATE

WELL DESIG	LWE	LWE
DATE	760706.0000	761109.0000
REC NO.	6520.0000	6540.0000
PH	7.6000	7.3000
ALKALINITY	60.0000	64.0000
CHLORIDE	350.0000	260.0000
COD	55.0000	25.0000
COND	3400.0000	3300.0000
TDS	2900.0000	3800.0000
TSS	150.0000	83.0000
SULFATE	1000.0000	3700.0000
ARSENIC	.0300	.0170
BORON	.5500	0.0000
CALCIUM	100.0000	0.0000
LEAD	.0130	0.0000
MAGNESIUM	11.0000	0.0000
MERCURY	.0002	.0004
SELENIUM	.0080	0.0000
SULFITE	0.0000	0.0000
SODIUM	610.0000	140.0000
TOTAL ELEM	2071.6012	4100.0174

POND E LEACHATE --- AEROSPACE ---

WELL DESIG	LWE	LWE	LWE	LWE	LWE
DATE	750319.0000	750707.0000	751103.0000	760121.0000	761109.0000
REC NO.	6600.0000	6620.0000	6640.0000	6660.0000	8740.0000
PH	8.8200	10.9600	9.7400	8.1000	7.5400
ALKALINITY	162.0000	568.0000	253.0000	79.0000	71.4000
CHLORIDE	1850.0000	740.0000	490.0000	520.0000	370.0000
COD	90.0000	245.0000	115.0000	60.0000	0.0000
COND	3900.0000	4160.0000	4000.0000	3330.0000	4180.0000
TDS	2720.0000	3200.0000	2690.0000	2640.0000	3750.0000
TSS	0.0000	0.0000	0.0000	0.0000	0.0000
SULFATE	250.0000	800.0000	900.0000	1075.0000	1950.0000
ARSENIC	.0100	.0800	.0140	.0760	.0320
BORON	1.6000	.6000	.6000	.5000	1.8000
CALCIUM	15.0000	20.0000	20.0000	30.0000	340.0000
LEAD	.1300	.0500	.0100	.0100	.0350
MAGNESIUM	30.0000	.5000	0.0000	.4000	22.0000
MERCURY	.0005	.0003	.0009	.0007	.0001
SELENIUM	.0120	.0430	.0180	.0050	.0013
SULFITE	.2000	.3000	38.0000	0.0000	0.0000
SODIUM	970.0000	970.0000	580.0000	540.0000	560.0000
TOTAL ELEM	3116.9525	2531.5733	2028.6429	2165.9917	3243.8684

POND E GROUND WELL 1

WELL DESIG	GWE1	GWE1	GWE1	GWE1	GWE1	GWE1	GWE1
DATE	750211.0000	750428.0000	750708.0000	750901.0000	751103.0000	760503.0000	760712.0000
REC NO.	6680.0000	6700.0000	6720.0000	6740.0000	6760.0000	6780.0000	6800.0000
PH	6.8000	7.0000	7.0000	7.0000	7.2000	7.3000	7.6000
ALKALINITY	220.0000	220.0000	230.0000	200.0000	210.0000	150.0000	130.0000
CHLORIDE	55.0000	36.0000	55.0000	40.0000	85.0000	38.0000	41.0000
COD	25.0000	10.0000	9.0000	9.0000	47.0000	19.0000	9.0000
COND	680.0000	630.0000	660.0000	580.0000	640.0000	640.0000	470.0000
TDS	420.0000	390.0000	560.0000	580.0000	410.0000	420.0000	370.0000
TSS	0.0000	90.0000	4600.0000	24000.0000	0.0000	140.0000	1600.0000
SULFATE	36.0000	37.0000	86.0000	460.0000	67.0000	150.0000	77.0000
ARSENIC	.0050	.0050	.0050	.0050	.0050	.0150	.0050
BORON	.2400	.1000	.1400	.2000	.1800	.0300	39.0000
CALCIUM	32.0000	26.0000	49.0000	85.0000	16.0000	65.0000	24.0000
LEAD	.0250	.0220	.5100	.2500	.6000	.1400	.4600
MAGNESIUM	9.4000	9.8000	19.0000	26.0000	98.0000	7.7000	9.6000
MERCURY	.0002	.0040	.0013	.0002	.0002	.0002	.0002
SELENIUM	.0020	.0020	.0030	.0020	.0010	.0060	.0010
SULFITE	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
SODIUM	0.0000	0.0000	92.0000	89.0000	120.0000	78.0000	79.0000
TOTAL ELEM	132.6722	108.9330	301.6593	700.4572	386.7862	338.8912	270.2662

POND E GROUND WELL 1--- AEROSPACE ---

WELL DESIG	GWE1	GWE1	GWE1	GWE1
DATE	750211.0000	750707.0000	751103.0000	760503.0000
REC NO.	6840.0000	6860.0000	6880.0000	6900.0000
PH	7.3400	7.2500	7.3700	7.7800
ALKALINITY	223.0000	217.0000	177.0000	0.0000
CHLORIDE	115.0000	71.0000	72.0000	62.0000
COD	50.0000	0.0000	10.0000	0.0000
COND	640.0000	550.0000	2440.0000	560.0000
TDS	416.0000	440.0000	380.0000	384.0000
TSS	0.0000	0.0000	0.0000	0.0000
SULFATE	28.0000	70.0000	55.0000	80.0000
ARSENIC	.0050	.0040	.0100	0.0000
BORON	.1000	.2000	.7000	1.0000
CALCIUM	32.0000	13.0000	8.0000	42.0000
LEAD	.0400	.0500	.0200	.0100
MAGNESIUM	15.0000	11.7000	12.0000	10.0000
MERCURY	.0003	.0004	.0003	0.0000
SELENIUM	.0050	.0005	.0020	0.0000
SULFITE	.3000	.6400	.3000	0.0000
SODIUM	0.0000	0.0000	99.0000	83.0000
TOTAL ELEM	190.4503	166.5949	247.0323	278.0100

POND E GROUND WELL 2

WELL DESIG	GWE2	GWE2	GWE2	GWE2	GWE2	GWE2	GWE2	GWE2
DATE	740805.0000	740903.0000	741007.0000	741028.0000	741104.0000	750211.0000	750428.0000	750708.0000
REC NO.	6920.0000	6940.0000	6960.0000	6980.0000	7000.0000	7020.0000	7200.0000	7040.0000
PH	7.0000	7.2000	7.2000	0.0000	7.0000	6.9000	6.8000	6.8000
ALKALINITY	110.0000	94.0000	170.0000	0.0000	100.0000	230.0000	160.0000	150.0000
CHLORIDE	50.0000	28.0000	66.0000	0.0000	29.0000	63.0000	46.0000	52.0000
COD	0.0000	0.0000	0.0000	0.0000	0.0000	860.0000	31.0000	120.0000
COND	0.0000	0.0000	0.0000	0.0000	490.0000	1000.0000	590.0000	600.0000
TDS	400.0000	220.0000	370.0000	0.0000	320.0000	460.0000	350.0000	480.0000
TSS	5400.0000	0.0000	180.0000	0.0000	190.0000	0.0000	25.0000	7500.0000
SULFATE	48.0000	26.0000	40.0000	0.0000	69.0000	52.0000	50.0000	89.0000
ARSENIC	.0230	.0050	.0050	.0050	.0050	.0050	.0050	.0050
BORON	.1000	.1000	.1000	.1000	.1000	.5000	.1500	.1800
CALCIUM	31.0000	22.0000	23.0000	0.0000	35.0000	72.0000	34.0000	62.0000
LEAD	.0950	.0160	.0100	0.0000	.0100	.8900	.0100	.2500
MAGNESIUM	24.0000	5.6000	8.3000	0.0000	8.8000	12.0000	8.5000	16.0000
MERCURY	.0002	.0002	.0002	0.0000	.0002	.0005	.0002	.0002
SELENIUM	.0020	.0020	.0020	.0020	.0020	.0020	.0020	.0020
SULFITE	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
SODIUM	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	-0.0000
TOTAL ELEM	153.2202	81.7232	137.4172	.1070	141.9172	200.3975	138.6672	219.4372

POND E GROUND WELL 2

WELL DESIG	GWE2	GWE2	GWE2
DATE	750901.0000	760503.0000	760712.0000
REC NO.	7060.0000	7080.0000	7100.0000
PH	7.0000	7.3000	7.8000
ALKALINITY	120.0000	200.0000	250.0000
CHLORIDE	32.0000	28.0000	38.0000
COD	37.0000	0.0000	37.0000
COND	480.0000	640.0000	570.0000
TDS	340.0000	430.0000	390.0000
TSS	29000.0000	550.0000	150.0000
SULFATE	150.0000	100.0000	15.0000
ARSENIC	.0150	.0050	.0050
BORON	.8000	.1000	.3800
CALCIUM	71.0000	55.0000	46.0000
LEAD	.0850	.0210	.1700
MAGNESIUM	11.0000	8.8000	8.4000
MERCURY	.0002	.0002	.0002
SELENIUM	.0020	.0040	.0010
SULFITE	0.0000	0.0000	0.0000
SODIUM	0.0000	-0.0000	0.0000
TOTAL ELEM	264.9022	191.9302	107.9562

POND E GROUND WELL 2--- AEROSPACE ---

WELL DESIG	GWE2	GWE2	GWE2	GWE2
DATE	741028.0000	750428.0000	750708.0000	760503.0000
REC NO.	7120.0000	7140.0000	7160.0000	7180.0000
PH	8.3600	7.6300	6.8900	7.5100
ALKALINITY	181.0000	0.0000	176.0000	0.0000
CHLORIDE	84.0000	125.0000	64.0000	62.0000
COD	50.0000	0.0000	15.0000	0.0000
COND	610.0000	640.0000	500.0000	620.0000
TDS	384.0000	544.0000	400.0000	522.0000
TSS	0.0000	0.0000	0.0000	0.0000
SULFATE	37.0000	56.0000	110.0000	110.0000
ARSENIC	.0050	.0050	.0040	0.0000
BORON	.3000	.6000	.2000	1.0000
CALCIUM	20.0000	20.0000	37.0000	63.0000
LEAD	.0300	.0900	.0500	.0100
MAGNESIUM	15.0000	12.0000	7.5000	11.0000
MERCURY	0.0000	0.0000	0.0000	0.0000
SELENIUM	.0040	.0030	.0010	0.0000
SULFITE	.3000	.7000	.4400	0.0000
SODIUM	79.0000	0.0000	0.0000	62.0000
TOTAL ELEM	235.6390	214.3980	219.1950	309.0100

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POND G GROUND WELL 2

WELL DESIG          GWG2        GWG2        GWG2
DATE         760720.0000 760914.0000 761115.0000
REC NO.        7300.0000   7340.0000   7420.0000
PH                7.2000      6.7000      6.3000
ALKALINITY      160.0000     94.0000     34.0000
CHLORIDE        140.0000    120.0000     45.0000
COD              42.0000     12.0000      0.0000
COND            730.0000    760.0000    630.0000
TDS             470.0000    580.0000    530.0000
TSS              84.0000    920.0000    590.0000
SULFATE          68.0000    200.0000    280.0000
ARSENIC            .0050       .0050       .0020
BORON              .1400       .2200       .2400
CALCIUM          71.0000     58.0000     50.0000
LEAD               .0350       .0340       .0500
MAGNESIUM        17.0000      5.7000     22.0000
MERCURY            .0002       .0002       .0007
SELENIUM           .0020       .0010       .0010
SULFITE           0.0000      0.0000      0.0000
SODIUM           71.0000     86.0000     88.0000
TOTAL ELEM      367.2322    469.9602    485.2937
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POND G GROUND WELL 2--- AEROSPACE ---

WELL DESIG          GWG2
DATE         761115.0000
REC NO.        8960.0000
PH                7.3700
ALKALINITY       30.0000
CHLORIDE         92.0000
COD               0.0000
COND            680.0000
TDS             446.0000
TSS               0.0000
SULFATE         240.0000
ARSENIC            .0010
BORON             1.6000
CALCIUM          48.0000
LEAD               .0300
MAGNESIUM        17.5000
MERCURY            .0001
SELENIUM           .0006
SULFITE           0.0000
SODIUM           80.0000
TOTAL ELEM      479.1317
```

POND H GROUND WELL 2

WELL DESIG	GWH2	GWH2
DATE	760720.0000	760914.0000
PEC NO.	7320.0000	7360.0000
PH	7.1000	7.1000
ALKALINITY	80.0000	170.0000
CHLORIDE	13.0000	93.0000
COD	45.0000	30.0000
COND	680.0000	590.0000
TDS	400.0000	400.0000
TSS	130.0000	71.0000
SULFATE	10.0000	39.0000
ARSENIC	.0050	.0050
BORON	.1200	.1400
CALCIUM	85.0000	72.0000
LEAD	.0430	.0480
MAGNESIUM	18.0000	22.0000
MERCURY	.0003	.0002
SELENIUM	.0010	.0010
SULFITE	0.0000	0.0000
SODIUM	63.0000	4.5000
TOTAL ELEM	189.1693	235.6942

APPENDIX C

ASSESSMENT OF THE CHEMICAL POLLUTION POTENTIAL ON THE ENVIRONMENT BY ALTERNATIVE DISPOSAL METHODS

Pollution of groundwater by the action of rainwater percolating through flue gas desulfurization (FGD) sludge is a genuine concern in the disposal of this material. Laboratory experimentation has shown that relatively high concentrations of dissolved chemical species in the liquor from untreated sludges persist in the leachate until at least 5 pore volume displacements (PVD) have passed through the sludge. Thereafter, the concentration depends on the solubility of the chemical phases in the sludge solids. The rate at which rainwater passes through FGD wastes has been measured in the range of 10^{-4} cm/sec, equivalent to soils of silty sand. The pollution of groundwater, determined by mass loading (mass/unit area) is calculated from the amount of pollutant that is carried by the leaching water to the groundwater.

The potential pollution that is possible from sludge when treated by any of several processors can be reduced by several orders of magnitude. Such an improvement has resulted from the (1) reduction of available chemical species (lower solubility) in the treated sludge, (2) reduction of standing rainwater by promoting runoff, and (3) reduction in the rate of water permeation through chemically treated material (lower permeability). In nearly every case, the eventual pollutant concentration of the leachate was less than one half that of the leachate from untreated sludge under similar conditions of FGD waste placement and disposal site management. Additionally, the runoff from treated waste can be more easily maximized, making less than 1/10 of the rainfall available for seepage. Since the permeation coefficient of treated waste is typically reduced by at least an order of magnitude, the mass loading per year to the groundwater may be reduced by a factor of 10 to 10,000. Thus, the real pollution measured by mass loading can be reduced by large amounts.

The consequence of much lower permeability rates of chemically treated sludge is that many years will pass before 5 PVD in the sludge will reduce the leachate concentration to the level of the soluble salts. Therefore, while the pollution of groundwater by untreated sludge can be severe for a short period of time and low thereafter, the pollution input caused by chemically treated sludge, at any given time, is never severe but will be sustained for much longer periods of time. The latter case is more consonant with nature, which weathers natural deposits slowly but constantly. However, since the high concentration of the leachate is not quickly flushed from treated FGD wastes, the potential exists that a later unexpected event could result in the release of soluble chemical constituents with the possible consequences of environment pollution. Such an event might be the result of a subsequent land use which requires extensive digging into the FGD sludge. Therefore, long-term land-use planning will be necessary.

An evaluation of the amount of chemical pollutants that are available to the environment by leaching can be determined from the results of the leaching data summarized in Figure C-1 and the permeability data summarized in a previous report.* An evaluation was made for an FGD waste containing 600 mg/ℓ dissolved solids in the mother liquor and disposed of by each of the alternative techniques discussed in Section 9. 3. The evaluation was made on the assumption that the leachate quality would respond according to the presentation in Figure C-1, and that the rate of passage of the leachate through the sludge would be 10^{-4} cm/sec for untreated sludge and 10^{-5} cm/sec for treated sludge. The waste was placed to a depth of 30 feet during a 5-year fill period. In the cases where the method of disposal was undrained ponding, it was assumed that a maximum hydraulic head of 6 feet was used during filling and a 1-foot head, thereafter, when retired as a lake.

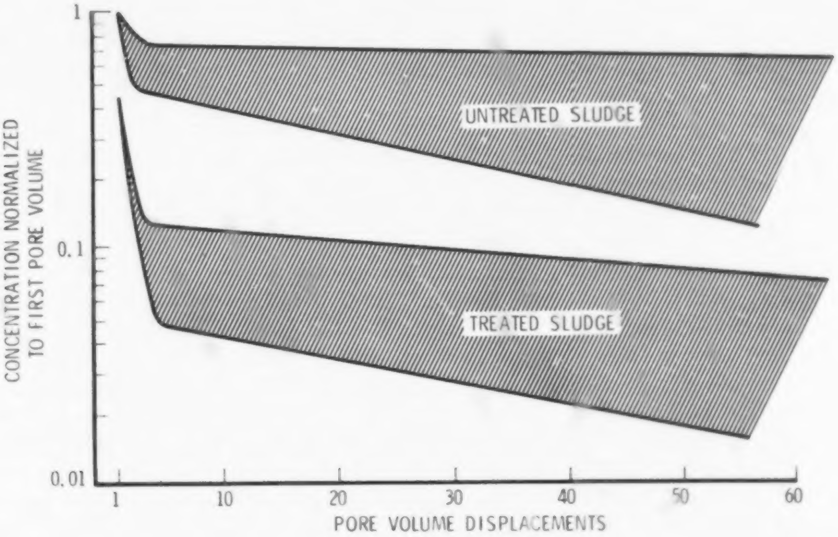

Figure C-1. Leachate TDS from treated and untreated sludges as a function of PVD.

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* J. Rossoff, et al., Disposal of By-Products from Nonregenerable Flue Gas Desulfurization Systems: Second Progress Report, EPA-600/7-77-052, U. S. Environmental Protection Agency, Research Triangle Park, North Carolina (May 1977).

The results of this evaluation are presented in Figure C-2 for cases described in Table C-1. Cases 1 and 2 represent the ponding technique of disposal in which the final disposition of the pond is a lake. Case 1 is for untreated FGD waste, and Case 2 is for treated waste. Cases 3 and 4 represent pond disposal of untreated and treated waste, respectively, in which supernate is not allowed on the surface of the pond during filling and the disposal site is retired by grading with the landscape. In these cases, the amount of water recharged to the basin represents a normal recharge for indigenous soil. Case 5 is the condition in which treated FGD waste is disposed of in a managed landfill where only 10 percent of the normal recharge is allowed to penetrate the waste because runoff has been maximized. Figure C-2 plots the total dissolved solids (TDS) that are expected to reach the disposal site subsoil per year as a function of time. Also plotted on each curve is an indication of the point in time at which the flushing action of the leachate reaches 5 PVD.

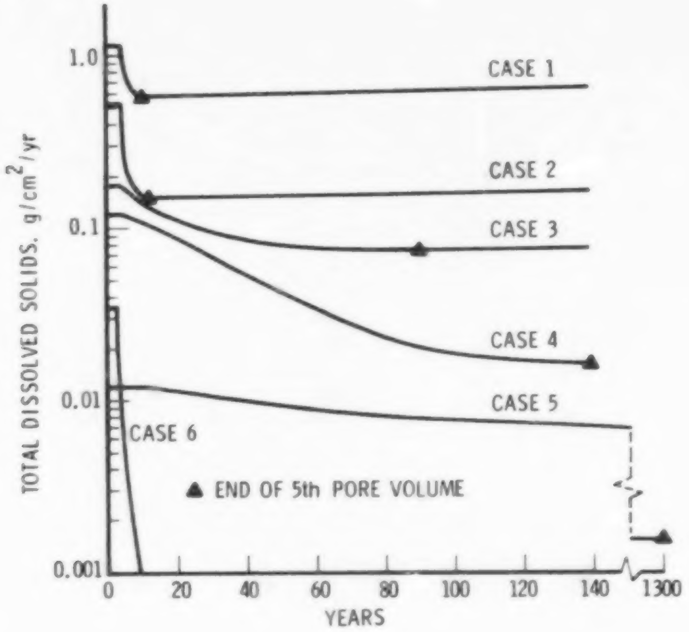

Figure C-2. Mass loading of TDS to subsoil for various disposal modes of treated and untreated FGC wastes.

This evaluation shows that, depending on the disposal method selected, the mass loading of pollutants to the groundwater can be reduced by as much as two orders of magnitude. Moreover, the significance of disposal site management as a means of preventing chemical pollution to the environment is clearly shown. Although chemical treatment reduced the pollutant load under each condition considered, the larger reduction in pollution load was a consequence of minimizing rainwater recharge to the subsoil of the disposal basin. This evaluation places in perspective the value of chemical treatment and site management with respect to the environmental acceptability of FGD waste disposal.

TABLE C-1. INPUT DATA FOR STUDY CASES

Case	Disposal Method	Surface Water	FGC Waste, 5-Year Fill			
			Waste Condition	Depth ft	Permeability, cm/sec[b]	Fractional Pore Volume
1	Lake[a]	Constant supernate	Untreated	30	10^{-4}	0.67
2	Lake[a]	Constant supernate	Treated	30	10^{-5}	0.67
3	Pond	10 in/yr recharge	Untreated	30	10^{-4}	0.67
4	Pond	10 in/yr recharge	Treated	30	10^{-5}	0.67
5	Landfill	1 in/yr recharge	Treated	30	10^{-5}	0.67

[a] Assumed maximum hydraulic head of 6 ft during filling, including depth of wastes; 1-ft constant water cover thereafter.

[b] For all cases, subsoil permeability = 10^{-5} cm/sec.

APPENDIX D

METHODS USED TO DETERMINE CHEMICAL AND PHYSICAL CHARACTERISTICS OF FGD SLUDGES

D. 1 METHODS OF CHEMICAL ANALYSIS USED BY AEROSPACE

This section describes the analytical techniques used by The Aerospace Corporation to determine the concentrations of constituents in the flue gas desulfurization (FGD) sludges and pond water samples. (The methods used by TVA are given in previous publications.)* The constituents present in the liquors and water samples are divided into the following: major chemical species (calcium, sulfate, and chloride), trace metal species, and additional chemical species. Other water quality tests are also described.

Consideration was given to the range of concentration of the constituents and to the corresponding costs of the analyses to obtain data having high precision and high accuracy.†

D. 1. 1 Major Chemical Species

D. 1. 1. 1 Calcium Determination

Atomic absorption spectrophotometry is presently used for calcium analyses. Results for solutions analyzed by this method were in

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* Methods for Chemical Analysis of Water and Wastes, Second Edition, Methods Development and Quality Assurance Research Laboratory, National Energy Research Center, Cincinnati, Ohio (1974).

Standard Methods for the Examination of Water and Wastewater, Thirteenth Edition, American Public Health Association, New York.

†Precision is defined as the relationship between a measured value and the statistical mean of measured values, and accuracy is the relationship between the true value and the mean measured value.

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agreement with those obtained by an oxalate titrimetric method to within 10 percent.

D. 1. 1. 2 Sulfate Determination

Standard nephelometry techniques were used for this analysis. A barium sulfate precipitate was formed by the reaction of the sulfate ion with a barium chloranilate reagent. The resulting turbidity was determined by a spectrophotometer and compared to a curve prepared from standard sulfate solutions. Although multiple dilutions are necessary to bring the concentration to a range of optimum reliability, the error is less than 10 percent.

D. 1. 1. 3 Chloride Determination

A specific ion electrode was used to determine the concentration of chloride ions. This method has a precision of about 1 percent and an accuracy of about 5 percent. Comparisons were made with results of titrations with silver nitrate. The chloride concentrations, measured with the electrode (1000 to 5000 ppm), in each case differed from the corresponding titration data by less than 5 percent.

D. 1. 2 Trace Metal Species

Atomic absorption spectrophotometry was used for analyses of the following elements: aluminum, antimony, arsenic, cadmium, chromium, copper, cobalt, iron, manganese, mercury, molybdenum, nickel, lead, selenium, silicon, silver, tin, vanadium, and zinc. Results were verified by analyzing National Bureau of Standards (NBS) standards. Precision and accuracy are dependent upon the means of activation, the specific element, its relative concentration, and the extent of interference by other elements and matrix effects. The precision and accuracy of the measurements of concentrations of all elements that exceed water quality reuse criteria ranged between 5 and 20 percent. However, the precision, with furnace activation, of trace metals occurring at very low levels is probably no better than 50 percent.

Mercury was also determined using this technique; however, the mercury was reduced to the elemental state with stannous chloride, and the absorption of the resulting mercury vapor was measured. This method has a precision of about 20 percent and an accuracy of about 50 percent.

D. 1. 3 Additional Chemical Species

D. 1. 3. 1 Sodium Determination

Atomic absorption spectrophotometry or flame photometry were used to determine sodium ion concentrations, depending on whether the concentrations were relatively low or high. Errors are typically less than 10 percent.

D. 1. 3. 2 Sulfite Determination

Total sulfite was determined using a specific ion electrode, and no significant interferences were observed. The oxidation of the sulfite ion to sulfate is a very rapid reaction. Scrubber liquor protected from the atmosphere typically shows sulfite concentrations of several hundred milligrams per liter; however, a brief atmospheric exposure causes oxidation and reduces these concentrations by one or more orders of magnitude. The reported sulfite measurements were for samples analyzed immediately upon arrival in the laboratory. No specific action was taken to inhibit oxidation other than to ensure that the samples were transported to the analytical laboratory in sealed containers. The exposure to air during sampling, filtering, and measuring, however, resulted in the reduced sulfite concentrations reported.

D. 1. 3. 3 Phosphate Determination

The phosphate analysis was determined by spectrophotometry methods, using ammonium molybdate to form the molybdenum blue complex.

D. 1. 3. 4 Nitrogen Determination

Total nitrogen was determined by the Kjeldahl method, which reduces all nitrogen to ammonia with sodium thiosulfate. The ammonia was then distilled and the amount determined by titration. This method has a precision of about 10 percent, and accuracy at the levels of the concentrations determined is about 25 percent.

D. 1. 3. 5 Fluoride Determination

The fluoride ion was determined by the specific ion electrode using a Beckman Model 4500 digital pH meter. There were no significant interferences. This method has a precision of about 5 percent; and accuracy of 20 percent is attainable at the low levels measured.

D. 1. 3. 6 Boron Determination

Boron was determined spectrophotometrically with the Hach DR2 using the Carmine method.

D. 1. 3. 7 Magnesium Determination

Magnesium was determined by atomic absorption spectrophotometry in the same manner as were the trace metals.

D. 1. 4 Other Water Quality Tests

D. 1. 4. 1 Chemical Oxygen Demand

Chemical oxygen demand was determined by reacting the organics and sulfites present with potassium dichromate and measuring the reduced chromium by spectrophotometry. While a precision of 25 percent is attainable, accuracy depends on the same history (i. e., degree of exposure to atmospheric oxygen) and is about 100 percent for routine analysis.

D. 1. 4. 2 Total Alkalinity

Total alkalinity was determined by titrating a 25-milliliter sample with standard acid to a pH of 4. 0. Total alkalinity is expressed as milligrams per liter calcium carbonate, but is actually a determination of the buffering capacity of the liquor due to a number of weak acid species (i. e., carbonate, sulfite, borate, arsenite, selenite, and silicate). Precision is about 5 percent, and accuracy is estimated to be about 25 percent.

D. 1. 4. 3 Total Dissolved Solids (TDS) Determination

The TDS were determined gravimetrically by evaporating a 25-milliliter sample overnight in a tared weighing bottle at 200°C. The precision is about 2 percent, and the accuracy is about 5 percent.

D. 1. 4. 4 Total Conductance Determination

This measurement, which was made with a General Radio Impedance Bridge Type 1650A, gave an estimate of the total ionic species in the sample. Precision is about 1 percent, and accuracy is estimated to be about 2 percent.

D. 1. 4. 5 pH Determination

This parameter was measured with a Beckman Model 4500 digital pH meter to a precision of 0. 005 pH units and an accuracy of 0. 01 pH units.

D. 1. 5 Analytical Methods Applicable to Sludge Solids

Sludge solids were analyzed for calcium, sulfate, sulfite, and carbonate in addition to total solids and inert material (fly ash).

Total calcium was determined by atomic absorption spectrophotometry after the sample had been dissolved in hydrochloric acid.

Sulfate was determined gravimetrically, taking a 1/4 gram sample which was dissolved in hydrochloric acid. The solution was filtered, and barium chloride was added to the hot filtrate to precipitate barium sulfate. This was filtered off through a tared Gooch crucible with a glass filter pad. It was then dried and ignited at 800°C, cooled, and weighed.

Sulfite was determined volumetrically. A 0. 5-gram sample was carefully acidified, using phenolphthalein indicator, then titrated directly with standard iodine using starch indicator.

Carbonate was determined by a gravimetric method, after evolution as CO_2, along with SO_2, by acidifying a 0.5-gram sample in a tared flask. The flask was warmed gently to expel all gases, cooled, and weighed. The weight decrease represents $CO_2 + SO_2$ and must be corrected for the SO_2 content determined by iodometric titration.

D.2 TESTING METHODS USED TO DETERMINE PHYSICAL CHARACTERISTICS OF TREATED SLUDGE

Rectangular parallelepiped samples were cut from the interior of the treated sludge cores for density, water content, and compressive strength measurements. Typically, the samples were about 1 sq in. in cross-sectional area and about 2 inches in height. After measurement of dimensions, the samples were weighed and placed in a vacuum oven at approximately 80°C for drying to constant weight. Compressive strengths were measured on the unconfined samples, both in the as-received condition of the cores and after drying, using an Instron testing machine to apply a compressive load at a constant rate of 0.02 in./min. The applied loads were recorded continuously until structural failures were observed.

Constant head permeability tests and leaching tests were made on monolithic samples of 4 to 6 inches in height. Five-inch diameter sections of treated sludge taken from the coring tube were sealed with silicone elastomer in plastic tubes. After addition of a 6-inch column of water above the sludge, the tubes were pressurized with nitrogen to 5 psi to accelerate the tests. The rate of permeation was measured and converted to permeability coefficients, and leachate samples were collected periodically. The pH and TDS were measured immediately, and analyses for the major constituents were made according to the procedures described under chemical analyses.